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TO ADVERTISERS

CHANGES for advertisements should be in this office by Friday noon for the following week's issue.
NEW ADVERTISEMENTS should be in the office not later than Monday noon to ensure publication in that week's issue.

The voluntary exiles on lightships have reason to bless wireless telegraphy. Their loneliness is relieved and they keep in touch with their fellows on land, to whom they render such vital service.

The electric tramway has penetrated to almost every place, no matter how remote. Even Spain has been compelled to yield to its onward march. Recently news has come of a very considerable tramway activity in that conservative country. New railways are being constructed in some of the leading cities, and a number of horse railways are to be changed over to electric power. It would seem that even the Spaniard is waking up to the fact that electric cars have some advantages over horse cars.

EFFECTS OF THE INTRODUCTION OF WIRELESS TELEGRAPHY.

A number of interesting remarks were made by Mr. Marconi at a dinner given in his honor by the Governor of Newfoundland regarding the part which wireless telegraphy is to take as a means of communication in the future.

There seems to be no doubt in Mr. Marconi's mind that a system of wireless telegraphy can be commercially established between different parts of the world which are widely separated and that an enormous cheapening of the rates of communication can be brought about. At the present rates charged by the cable companies communication by them is so expensive that it is beyond the reach of the majority. It is his idea that the cost of cabling can be reduced at least twentyfold and thus vastly increase the amount of communication between a home country and its colonies, which would tend very greatly to unify and strengthen it. This would apply particularly to British possessions.

If a system of syntonic wireless telegraphy has been discovered or can be in the near future it would seem that there is no great reason why this should not be accomplished. Of course, a large amount of preliminary work of development yet remains to be done.

One great result which this achievement of Mr. Marconi should have upon the cable companies is to cause them to exert themselves to the utmost to discover means by which messages can be transmitted much more rapidly than at present and thus the amount of work which can be done over a single cable be very greatly increased. Judging from the improvements and discoveries which have taken place recently in the methods of communication in which electrical circuits are employed, it would seem that such efforts should result in greatly increasing the efficiency of the cables now in use.

AN EXPERIMENT IN DEVELOPMENT.

Before the recent meeting of the American Society of Mechanical Engineers there was presented a paper entitled "A Bonus System of Rewarding Labor," by Mr. H. L. Gantt, of the Bethlehem Steel Company, which, despite its modesty, is believed by many competent critics possibly to mark the beginning of a movement that will become little short of an industrial revolution. The idea, as set forth in Mr. Gantt's paper, is to effect in large manufacturing establishments a combination between the manual skill and knowledge of handicraft of the man at the machine and the technical knowledge, education and experience of the engineer in charge of the work, so as to effect a considerable saving in labor and cost of manufacturing, and a very great decrease in the time requisite for performing manufacturing operations upon crude material. The system, in brief, is this: When a piece of work is put into the shop requiring, for example, the operations of planing, turning, drilling or other work to be done upon it, a very carefully prepared chart is given to the man who is to do the work, giving him minute instructions as to the best way to do it, with careful estimates of the time necessary for the performance of each operation. The sum of these times is the total time needed to complete the work. The man is paid a definite day rate for his work, but, in addition to this, if he follows his instructions and accomplishes all the work laid out for him, he earns a definite and substantial bonus in addition to his regular wages. The foremen, under this system, also receive a bonus proportional to the number of their men earning extra compensation.

The thing is so simple and so evident that one wonders that it has not been done before. It will be seen that this system effectually combines in every piece of work the best knowledge that can be brought to bear upon it, together with the

highest degree of mechanical skill in its performance. The results given by Mr. Gantt are simply astonishing. The moral effect upon the men where the experiment was tried—in the great machine shops of the Bethlehem Steel Company—was excellent and the percentage of errors in machining was at once materially reduced. The condition of the tools was improved, while the amount of time taken to do various pieces of work was reduced to an extraordinary degree. For example, the time on a locomotive driving axle, formerly rated at six and one-half hours, has been reduced to one and one-half hours; the time required to finish the crank shafts for a well-known type of engine was formerly forty-six and one-half hours and has been reduced to twenty-six and one-quarter hours; but the most significant figure is that showing the output of the shop.

During the year ending March 1, 1901, the machine shop was run as hard as the machines could be pushed, night and day, and yet the increasing output of the forge was piling up work ahead of it. Beginning with the month of March, in which the system was introduced, the monthly output of the shop increased from a figure for the first month twenty-five per cent greater than the average for the preceding year, until, in July, the shop was turning out more than twice as much work as it had ever done before.

Important as are the results indicated to the manufacturing corporation employing this system, yet the education of the men which is accomplished by its use is even of more general and particular value. While no system can supply a man with brains, still the evident effect of this method is to make the men think and to make them learn, and into the hands of each workman is given the crystallized experience of the skilled engineers who prepare the charts, and a sufficient incentive to make him learn thoroughly the lesson. The author of this system is to be congratulated in having inaugurated an important work whose benefits can not at present even be estimated.

An alleged inventor of visual telephony hails from Belgium. In this case truly "seeing is believing;" the state of the art, however, justifies unbelief.

THE GIVING OF MONEY.

It is very gratifying to see that such a large proportion of the people who have money to give for the benefit of their fellow men has learned that in order to have the gifts accomplish the greatest good they must be given intelligently. It was often the case formerly that men gave money to gratify some whim or as a result of some idea which suddenly took possession of them. Formerly a number of conditions were attached to almost every gift, which rendered it, in many cases, almost of no account for the object for which it was intended.

At the present time men have learned to study the needs of the human race and to decide either by their own observations or by that of other wise individuals for what money ought to be given to have it accomplish the greatest results. Almost no conditions as to how they shall be used are attached to the great benefactions, which makes it possible for them to be expended to the greatest advantage for the purpose intended.

Already a large amount of money has been given to provide means for attacking certain definite scientific and practical problems, but not nearly enough has been devoted to this purpose. There are still a large number of problems remaining in the electrical field to which a much greater amount of study ought to be devoted. The solution of these problems would bring great renown upon those who accomplished it and upon those who gave the necessary funds, and would add very greatly to the sum total of the comforts of humanity.

Among these problems is the one of a more economical method of transforming the heat energy in coal into mechanical energy. The acquisition of a much cheaper mode of producing power would benefit the race mightily in all parts of the world.

Of late a good deal of attention has been paid to the action of the various kinds of radiations upon disease germs. In many cases it would seem that the efforts had been attended with a considerable measure of success, and that the problem was worthy of a much deeper and more thorough study. Certainly the benefits resulting from the use of the X-ray in surgery have been ample enough to justify the large amount of work which brought about its discovery.

Money given for attacking any one of a number of great problems which are before the public at the present time is sure to result in great additions to human knowledge and in many cases in the solution of such problems.

In this age, when so many are engaged in the pursuit of gain, few stop to think of the man who devotes his life to the acquisition of knowledge. Almost without exception scientific men receive little compensation for their services, although a man of much more than ordinary ability is required for such work. It is only when their unselfish efforts are rewarded with some brilliant discovery that the world ever hears of them, and partially rewards them for what they have accomplished. It is to be hoped that the day will come some time when such work will receive its just recompense, for upon it depends every great advancement of the human race. The increased amount of money which is being devoted to pure research and the interest which the leading nations of the world are taking in it augurs much better for the future.

One of the most notable tendencies in the electrical world toward the close of the year has been the consolidation of the different electrical interests throughout the United States. In every department of electrical work large combinations have taken place. A number of railways in different parts of the country have united to form one company or have formed a union for mutual interchange of traffic. This tendency has also been extremely noticeable in the telephone world. Important consolidations of independent telephone companies have taken place in a number of places in the South and Middle West. A number of electric lighting companies have been formed to take over smaller companies and unite them in one large concern. In short, the tendency toward consolidation is quite as noticeable throughout the electrical field at present as in any other line of business activity.

Science Brevities

A New Form of Permeameter—A description of a new form of permeameter has been published in *Nature*. Mr. C. V. Drysdale has communicated to the Institution of Electrical Engineers a description of a new form of permeameter for testing the magnetic qualities of iron and steel in bulk. A special form of hollow drill is used to drill a hole five-eighths inch deep in the material to be tested; this hole has its upper part conical, and the small central pin left standing is one-tenth inch in diameter. Into this hole fits a soft iron plug, on the lower part of which are wound the magnetizing and testing coils. There is thus formed a miniature permeameter in which nearly the whole of the magnetic circuit is of the material under test. By connecting the coils in the plug with suitably graduated instruments the permeability, retentivity and hysteresis may be very easily tested. Curves and figures which were published showed that the instrument gave very consistent results, although, as was pointed out in the discussion, they did not agree as well as they might with the values usually obtained by other permeameters. But the simplicity of the apparatus and the ease with which a test can be obtained (if, that is, the drills can be made to act with uniform accuracy) should give it considerable commercial value. The dynamo manufacturer requires chiefly a rough guide to the permeability of the casting he is going to use and does not need very rigid scientific accuracy, and such a guide Mr. Drysdale's instrument should be able to provide. In fact, any method which only really tests a very small portion of the bulk, whether *in situ*, as in this case, or after it has been cut off, can never be thoroughly satisfactory.

Dielectric Constants of Paraffins—A very interesting paper upon this subject has been published by Mr. Will G. Hormell in a recent number of the *American Journal of Science*. This work was carried out in the Jefferson Physical Laboratory at Harvard University. For these experiments a modified form of the Blondlot oscillator was used to obtain the dielectric constants of four commercially different paraffins for forty, sixty and eighty-centimetre waves. In this paper also is contained an investigation of the relative velocities of eighty-centimetre waves along magnetic and non-magnetic wires of different diameters. Finally there is given in a table by way of comparison the light index of refraction of the different paraffins for the D_1 line as obtained by means of the Abbe refractometer. The following conclusions were reached as a result of the work: (1) For reversals as high as 800,000,000 per second the velocity of electrical disturbances along magnetic and non-magnetic wires of different diameters is the same, thus showing that the magnetic properties of iron are not able to follow such rapid changes. (2) The effective field around the Lecher wires as far as it can be detected by means of an argon tube, does not extend more than three centimetres from the wires, and the effect on the half wave within this region varies approximately inversely as the square of the distance from the wires. (3) The dielectric constant of a given paraffin increases with the density of the paraffin. It increases rapidly from a temperature twenty degrees above the melting point to a temperature thirty degrees below the melting point. Among different paraffins the dielectric constant increases as the melting point of the paraffin increases. (4) The dielectric constant increases as the wavelength decreases. It is greater for short, light waves than it is for short electrical waves. Cauchy's formula as a means of obtaining the index of refraction for indefinitely long waves does not meet the experimental facts.

Recent Work on the Spark and Glow Spectra of Gases—M. Berthelot has published an interesting paper on this subject in a Continental journal. This paper has been abstracted in *Lightning*. M. Berthelot applies the induction coil and spectroscope to the rapid analysis of gases by means of a simple apparatus whereby the gas, confined over mercury, is subjected to a discharge between terminals at easily adjustable distances, one fused into the top of the eudiometer, and the other, insulated in a glass tube, introduced through the mercury. It suggests itself whether the lower wire could not be insulated with gutta-percha instead of glass, as pliable and more easy to manage. The coil had a rapid interrupter, Leyden jar and two accumulators, and five to ten cc. of gas were sparked, continuing only for a few seconds to avoid heating and decomposition. The paper contains a chart of lines and bands. Messrs. Liveing and Dewar (*R. Soc. Proc.*, lxviii, 389) separate the least volatile of the new gases from air by allowing the solidified gases to evaporate slowly through a glow tube and observing the spectrum, so using the spectrum in the same way as the thermometer in ordinary fractional distillation. Messrs. Ramsay and Travers publish in the *Phil. Trans.* for October a monograph on these gases. The colors given by the discharge are: *Argon*, reddish violet; *helium*, yellow; *neon*, flame-color; *krypton*, pale violet; *xenon*, sky blue. The line spectra of the last three are given and explain the genesis of these colors. Exact measurements are announced for publication shortly. Professor Pickering, of Harvard Observatory, has succeeded in taking a number of photographic spectra of lightning flashes. He considers that he has obtained evidence of the compound nature of hydrogen and others of the commonly accepted elements.

The Spreading Out of the Lines of Electrolytic Action in Electrolytes—In a recent number of the *Zeitschrift für Elektrochemie* Herr W. Pfaunhauser discusses the cause of irregular deposition of metals at the cathode, and shows that this phenomenon is due to the spreading out of the lines of electrolytic action between the anode and cathode. An abstract of this article has been published in a London contemporary. An analogous case is the spreading out of the lines of magnetic force between the poles of an electromagnet. The most commonly observed effect of this in electrodeposition is the thickened deposit at the edges of flat cathodes. In electroplating work this defect is avoided by making use of a diaphragm or screen of non-conducting material. This is placed in front of the cathode and cuts off the outer lines of electrolytic action. The author brings forward a theory in explanation of this spreading out of the lines of electrolytic action, and shows by mathematical reasoning that it is dependent upon three of the physical constants of the electrolyte during the electrolysis. The difference between the discharge potential of the various cations in the electrolyte is the most important of these, and the spreading out of the electrolytic lines of action varies directly as this difference. The distance separating the two electrodes and the specific resistance of the electrolyte are the two other conditions which affect this phenomenon—in this case the ratio is an inverse one. By regulating these conditions it is therefore possible to obtain an electrolytic depositing bath in which the lines of electrolytic action shall be only slightly spread out at the middle point of their path, and in which, consequently, uniform deposits can be obtained upon articles of irregular shape without special devices in the form of diaphragms or secondary anodes.

THE THEORY OF ALTERNATING DYNAMO ELECTRIC MECHANISMS—LI.

BY W. ELWELL GOLDSBOROUGH.

Now, since the points A_7, A_8 and A_9 of Fig. 125 are determined in their proper positions relatively to the three-phase electro-motive-force vectors, the electro-motive forces apparent at the terminals of the receiving circuits can at once be obtained by measuring the vector distances, A_7A_9, A_8A_7 and A_9A_8. Therefore, the electro-motive force finally impressed on the circuit A_7A_9 is equal to 1,198 volts. The electro-motive force finally apparent at the terminals $A_8A_7 = 1{,}121$ volts. And the electro-motive force finally apparent at the terminals $A_9A_8 = 1{,}337$ volts. 41,300 watts, and, finally, in the circuit A_9A_8 a current equal to $A_9B_9 = 41.3$ amperes flows, developing power equal to 36,400 watts.

In the distributing lines, we find that larger currents are flowing. For instance, in the line A_1A_7 a current equal to $O'B_1 = 85.3$ amperes is set up, causing a loss of power in this line of 48,200 watts. In the line A_2A_8 a current equal to $O'B_8 = 78$ amperes is set up, causing a loss of 41,600 watts. In the line A_3A_9, a current of 66.9 amperes is set up, causing a loss of 29,600 watts; consequently, our vector analysis shows that a total of 254,100 watts is absorbed in the system as a whole, of which 134,700 watts is again available through the receivers.

A_9A_8 when phase E^I is active,
A_7A_9 when phase E^{II} is active, and
A_8A_7 when phase E^{III} is active,

are entirely warranted

Under present conditions, the vector distance $A'_8A''_8$ of Fig. 125 is 96 volts. With like receiver constants and line constants modified so as to allow a loss of only 10 per cent in the distributing mains, the potential difference between A'_8 and A''_8 of Fig. 125 would be reduced to 12 volts. This pressure acting upon the circuit A_8A_7 would set up a current so small as to be entirely inappreciable in solving the problem. But for the fact that the line losses are higher than those common in practice, example 24 is entirely representative of modern practice

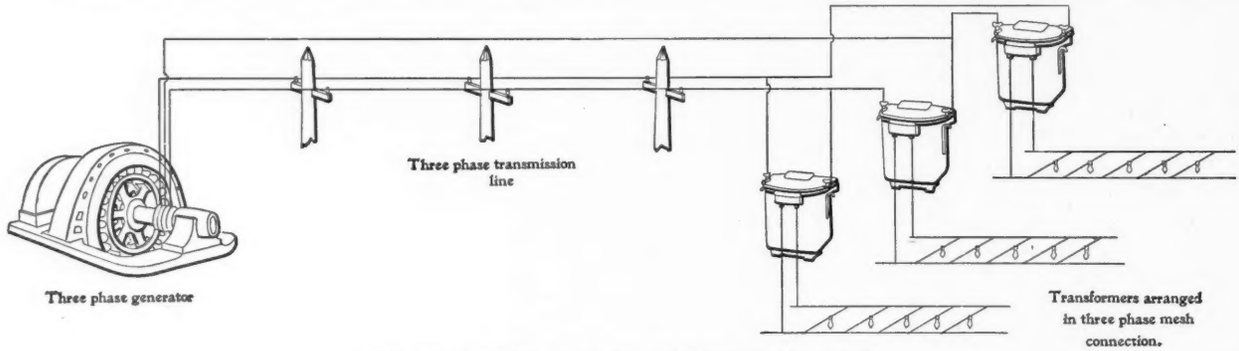


FIG. 127.—ALTERNATING DYNAMO ELECTRIC MECHANISM.

These receiver electro-motive forces can, of course, also be determined by taking the vector sum of the electro-motive forces apparent at their terminals when the phases were separately active. For instance, the final electro-motive force A_7A_9 appearing at the terminals of the circuit A_7A_9 is equal to the vector sum of the vectors $A_9{}^IA_7{}^I$, $A_9{}^{II}A_7{}^{II}$ and $A_7{}^{III}A_9{}^{III}$, since these were active at the terminals of this circuit when E^I, E^{II} and E^{III} were separately impressed upon the system. That this is true is shown by the vectors $A_9A''_7$, $A''_7A'_7$ and $A_7A'_7$ drawn equal and parallel to the three partial vectors just referred to.

Now, since the final values of the electro-motive forces which are impressed at the terminals of the several parts of the system under discussion are determined, it is a simple matter to obtain the values of the currents flowing, since the constants of each circuit in the system are known. Accordingly, we find that a current equal to the vector $A_7B_7 = 49.3$ amperes flows in the circuit A_7A_9 with a lag of 15 degrees behind the electro-motive force A_7A_9 apparent at the terminals of this circuit. The power delivered to this receiver is, accordingly, 57,000 watts. Likewise, a current of 43.8 amperes flows in the circuit A_8A_7, developing therein

Now, our phase diagram of Fig. 126 shows that the current $O'B_1$ lags behind the vector $O'A^I = E^I = 1{,}200$ volts by an angle of 18 degrees. This phase of the generator, therefore, develops 97,400 watts. Similarly, since the vector $O'B_2$ is equal to 78 amperes and lags 30 degrees behind the phase vector $O'A^{II} = E^{II} = 1{,}200$ volts, 81,100 watts are developed in this phase of the generator.

In the third phase of the generator, the current lags 19 degrees behind the electro-motive force there developed and has a value of 66.9 amperes. Consequently, 76,000 watts are developed in this phase. The total power developed by the generator is, therefore, 254,500 watts, a value practically equal to that found by previous calculation of the power absorbed in the lines and receivers.

If we take the ratio of the total power developed by the alternator to the total power delivered to the receivers, we find that the efficiency of the transmission is equal to

$$\frac{\text{Useful Energy}}{\text{Total Energy}} = \frac{134{,}700}{254{,}500} = 53 \text{ per cent.}$$

This efficiency of 53 per cent is very much lower than that which could profitably be employed in practice. We therefore see that the suggestions previously made relative to neglecting the circuits, in the transmission of power over moderate distances by three-phase alternating currents. The data resulting from these reductions is tabulated in Table 17.

TABLE 17.

Data pertaining to Fig. 126. All three phases active.

Circuits. See Fig. 117.	Impressed E. M. F. E	Resistance E. M. F. E_r	Reactance E. M. F. E_x	Current Amperes. I	Current Sag in Degrees. ϕ	Power in Watts. P
AA	574	565	100	85.3	10	48,200
AA	541	533	94	78.0	10	41,600
AA	450	443	78	66.9	10	29,600
AA	1,198	1,155	312	49.3	15	57,000
AA	1,121	942	608	43.8	33	41,000
AA	1,337	881	1,005	41.3	49	36,400
Total power absorbed in lines and receivers..						254,100
E^I	1,200	1,141	362	85.3	18	97,400
E^{II}	1,200	1,040	600	78.0	39	81,100
E^{III}	1,200	1,137	383	66.9	19	76,000
Total power delivered by alternator						254,500
Total power delivered to receivers.....						134,700
Efficiency of transmission						53%

A Useful Donation.

Mr. John F. Wentz has given $5,000 to the engineering department of the University of Pennsylvania. The large number of gifts which have recently been made to our scientific and technical schools should do much toward raising their standard of instruction.

The Theory and Calculations of Alternating-Current Transmission Lines.

By Charles W. Startsman. of sales department, Crocker-Wheeler Co.

THE DECADE just closed has seen wonderful advances in the use of electricity as a motive power and for lighting. Nearly every city has been witness to the passing away of the horse car and its replacement by the trolley. Machine shops and factories are tearing out long lines of shafting and putting up numbers of individual motors at a high increase of efficiency upon the total power necessary. Small cities, and even towns and villages, are vieing with one another to secure the best lighted streets.

To keep pace with this demand has come a cry for new sources of power, and what was more natural than that the eyes of the inventors and engineers should turn toward the waterfalls with which many sections of our country are particularly blessed? But numerous as they are, nature and men have not worked hand in hand in the location of these constant sources of supply and the centres of population and industry where the power is called for, and it is one of the great problems which confronts the electrical engineer of to-day, how to economically connect the two, though separated by hundreds of miles.

It is not the purpose of this article to attempt to solve a problem which is puzzling the most eminent engineers, but rather, by a more or less complete discussion of the subject, to point out the great difficulties attending electric power transmission and to show where we stand to-day in the solution of the question.

Electric transmission might at once divide itself under the following heads:

(1) Underground cable transmission, or (2) overhead pole-line construction.

The first of these, while possessing advantages, such as freedom from atmospheric disturbances, is infinitely more expensive and only suitable for a crowded city, where it often becomes imperative. Through an open country the latter is the only one to be thought of.

Secondly, the character of the current itself presents a new division—alternating or direct current. The latter has undoubted advantage over the first, since all capacity and inductance effects are absent. No electric oscillations will be set up to puncture the insulation of the receiving circuit or arc across from wire to wire. All this would mean a great simplifying of the subject and admit of a great deal of progress toward the solution, if it were not that practical engineering to-day can give us no means of producing high direct voltages and transforming to low voltage again for a motor or light. It is not necessary to do more than call attention to the fact that the success of long-distance transmission demands the use of high voltages, so that for a given amount of power the current may be small and allow the use of a small wire. This not only means a lighter pole line, but an immense saving in the cost of conductor, which is one of the largest items to be dealt with.

On the other hand, by means of the static transformer, we can produce as high an alternating voltage as we please and by the same means transform it down again to as low a value as may be required. Both of these accomplished at a wonderfully high efficiency as compared with the dynamotor, which does the same thing for direct current. The voltage of this machine is limited at 1,000 volts or so, on account of disastrous sparking at the commutator. So we see that whatever disadvantages may follow the use of alternating current, successful long-distance transmission requires its use, and this is the subject of the discussion.

As is well known, transmission of a direct current over a line of any length, such as the trolley wire, for instance, involves a loss of potential due to the resistance of the wire, commonly called the line drop. This is a quantity easily figured, knowing the size and length of wire and the amount of current flowing. Alternating-current transmission admits of no such simple solution. Many factors enter the problem and it is proper in commencing the discussion that we should examine briefly as to what these factors are, and, having a given line, how they may be determined.

Resistance, of course, still enters, the same as in a direct-current circuit. In fact, with alternating current the resistance is even slightly higher, due to unequal distribution of the current. The central portion of the wire has greater space around it and sets up a slightly greater self-induction flux than that portion near the surface. This higher flux means a higher back electro-motive force, hence slightly less current at the centre and a crowding of the current toward the surface of the wire, called "skin effect," and only noticeable with large conductors at high frequencies. The tendency, by increasing the current density, is to increase the resistance of the wire. However, in an ordinary transmission line, this effect is negligible.

The constantly changing current of an alternating-current line means a constantly changing magnetic field about the wires. This changing flux induces a back electro-motive force in the conductor and requires a certain portion of the impressed electro-motive force to overcome it. It is the electro-motive force of self-induction and is 90 degrees ahead of the current in phase.

If there are any conductors in the immediate neighborhood of the line, or large masses of metal, this changing flux will induce secondary currents in these conductors or this metal, which will, in turn, react on our line and set up electro-motive forces of mutual inductance. This electro-motive force is out of phase, but not by 90 degrees, with the current, and hence is resolved into two components, an energy component in phase with the current, which acts as an increase of resistance, and a wattless component in quadrature with the current. In telephone circuits mutual inductance is often a disturbing element, producing cross-talk, etc., but in the isolated pole line of long-distance transmission we may easily neglect it.

The alternating field of force may produce, in some materials, a loss of energy by hysteresis. It is an expenditure of electro-motive force in phase with the current and is noticeable only in large iron conductors.

An alternating-current transmission line often has comparatively large capacity and the effect of this may be considerable. It requires the expenditure of a charging current of 90 degrees ahead of the electro-motive force; that is, when the electro-motive force is changing fastest the charging current is a maximum. It will increase or decrease the main current according to the phase relation of the latter with respect to the electro-motive force.

Though with the best form of insulators leakage is small, still no insulator has

an infinite resistance and at high potentials there may be a perceptible leakage of current from one wire over the insulator along the cross-arm to the opposite wire. Also, unless the wires are very far apart and high from the ground, there will be an actual discharge through the air to opposite conductor or to ground. All this means a loss of current.

The alternating potential of the line will produce, by electrostatic influence, charges in any neighboring conductor, retaining an opposite charge upon itself. It means the flow of a useless current, but in the ordinary line would amount to practically nothing.

This mentions nearly all the factors liable to affect an alternating-current transmission line. Some are of considerable importance, others are not, but in starting out to figure a line we should determine with some degree of accuracy the following four constants:

1. Effective resistance (r) represents electro-motive force consumed in phase with the current.

2. Effective reactance (x) = ω L, L being the coefficient of self-induction of the line, represents electro-motive force consumed in quadrature with the current.

3. Effective conductance (g) due to the leakage current, represents current consumed in phase with the electro-motive force.

4. Effective susceptance (b_c), due to capacity and representing current consumed in quadrature with the electro-motive force.

1. Resistance (r) may be considered the same for alternating as for direct current, and is given by the formula:

$$R = \frac{10.35 \times l}{M}$$

where l is the length in feet and M the circular mils. This assumes a temperature of 20 degrees centigrade or 68 degrees Farhenheit, which is sufficiently accurate for most purposes.

2. Reactance $(x) = 2\pi f$ L, where f is the frequency and usually known, L the coefficient of self-induction. This coefficient L we know to be found by ascertaining the flux which a given current sets up. It is then the ratio between the flux N and the current i.

Let us assume a single-phase line a-b, wires of a radius r, and separated by a distance d.

Flux threading dx, per unit length of line, is set up by a magneto-motive force of $4\pi i$ acting through a magnetic reluctance $\frac{2\pi x}{dx}$. If dx is within the wire carrying the magnetizing current, the magneto-motive force is $4\pi\left(\frac{x^2}{r^2}\right)\left(\frac{x^2}{r^2}\,i\right)$ with a magnetic reluctance of $\frac{1}{\mu}\,\frac{2\pi x}{dx}$. μ for copper is 1. We have then as an expression for the flux, integrating between proper limits

$$N = \frac{\text{m. m. f.}}{\text{m. r.}} = \int_r^{d-r} \frac{4\pi i}{\frac{2\pi x}{dx}} + \int_0^r \frac{4\pi \frac{x^4}{r^4} i}{\frac{2\pi x}{dx}}$$

$$= \int_r^{d-r} \frac{2 i\, dx}{x} + \int_0^r \frac{2 i x^3 dx}{r^4} = 2i \log \times \left| \begin{matrix} d-r \\ + \frac{2i}{4}\frac{x^4}{r^4} \end{matrix} \right|_r^r$$

$$= 2i \log\left(\frac{d-r}{r}\right) + \frac{2i}{4}.$$

d is usually large compared with r, hence

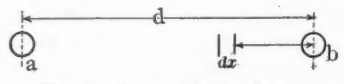


Fig. 1.—Single-Phase Line.

$\frac{d-r}{r}$ is closely approximated by $\frac{d}{r}$ so that

$$L = \frac{N}{i} = 2 \log_e\left(\frac{d}{r}\right) + \frac{1}{2}$$

in centimetre-gramme-second units of inductance per cm. of wire, or per mile for each wire in henrys,

$$L = \left(80.5 + 740 \log_{10} \frac{d}{r}\right) 10^{-6}$$

If the line is three-phase, the coefficient of self-induction is given by

$$L = 2\sqrt{3}\left(\log_e\left(\frac{d}{r}\right) + \frac{1}{4}\right)$$

or per mile of the whole circuit in henrys,

$$L = \left(139.26 + 1{,}280 \log \frac{d}{r}\right) 10^{-6}$$

This assumes the wires placed at the

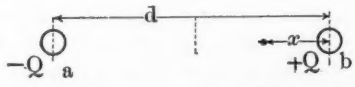


Fig. 2.—Distribution of Capacity.

corners of an equilateral triangle, in which case wire c has no effect on wires a and b, which combine geometrically to give the total inductance $\sqrt{3}$ times as large as of one wire.

3. Conductance (g) of the leakage current is ordinarily an extremely difficult value to ascertain. If the wires were insulated, insulation test for resistance would give a means for approximation. With bare wires and a pole line, the value of leakage current might be found by erecting a pole with insulators and wire complete, subjecting the wires to an extremely high potential, break the cross-arms and insert leads to a sensitive galvanometer. Then the approximate resistance from wire to wire could be thus obtained by the voltage-current method.

4. Susceptance (b_c) due to capacity of the wires. $b_c = \omega c = 2\pi f c$, where f is known frequency and c capacity. The latter we know is the ratio between the charge residing on the wire and the voltage necessary to charge.

First consider two wires of opposite potential a and b, one holding a charge of $+Q$ and the other of $-Q$ units, per unit length of line.

Suppose we have a small unit charge q which we will move from the plane of zero potential to the surface of b. Assume it to be at a point distant x from the axis of b. The field intensity at this point is given thus:

Flux from b is 4π Q through an area of $2\pi x$ assuming a unit length of wire. Therefore, field intensity due to b is:

$$\frac{4\pi Q}{2\pi x} = \frac{2Q}{x}$$

Field intensity due to a is:

$$\frac{4\pi Q}{2\pi(d-x)} = -\frac{2Q}{d-x}$$

Resultant field intensity calling q of negative potential:

$$F = \frac{2Q}{x} - \left(\frac{-2Q}{d-x}\right)$$

$$= \frac{2Q}{x} + \frac{2Q}{d-x}$$

Multiply by dx and integrate between limits $\frac{d}{2}$ and r, which means we have moved q from zero potential to b, and given it a potential of

$$E = \int_r^{\frac{d}{2}} \frac{2Q\,dx}{x} + \int_r^{\frac{d}{2}} \frac{2Q\,dx}{d-x}$$

$$= 2Q \log x \Big|_r^{\frac{d}{2}} - 2Q \log(d-x) \Big|_r^{\frac{d}{2}} = 2Q \log\left(\frac{d-r}{r}\right)$$

or since r is small compared to d

$$E = 2Q \log \frac{d}{r}$$

Charge being Q.

$$\text{Capacity } C = \frac{Q}{2Q \log \frac{d}{r}} = \frac{1}{2 \log \frac{d}{r}},$$

between one wire and the neutral point, or in microfarads per mile.

$$C = \frac{.0776}{2 \log \frac{d}{r}}.$$

If a three-phase line is used it can be shown by a similar discussion and has been proved by experiment, that capacities have a Y connection, as in Fig. 3,

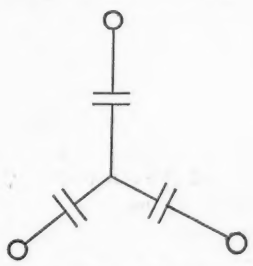


FIG 3.—THREE-PHASE LINE.

and $C = \frac{1}{2 \log \frac{d}{r}}$ between one wire and the neutral point.

Two solutions are now open—the graphical or topographical method, and the differential method.

The topographical method will be discussed first.

We will assume the electro-motive

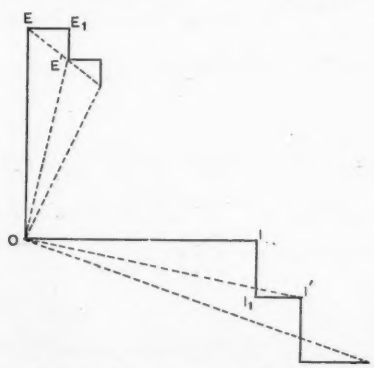


FIG. 4.—TOPOGRAPHICAL DIAGRAM.

force at the receiving end to be 10,000 volts and the current 100 amperes, with a lead of 90 degrees, and hence a power factor of 0. Also assume the line constants per unit length $r = 1$, $x = 4$, $g = 2 \times 10^{-5}$, and $b = 20 \times 10^{-5}$, where r is effective resistance, x = effective reactance, g = effective conductance, and $-b$ = effective susceptance.

Now, in the adjacent diagram, suppose we consider O as the point of zero potential and zero current and let OI represent the current at the receiver end and OE the electro-motive force. The line OE will be perpendicular to OI, since the power factor is zero and the electro-motive force is 90 degrees behind the current. Suppose the transmission line to be divided into a number of elements; then, starting from the receiver end, we will work toward the generator, finding the electro-motive force and current at the generator end of each element. To do this, lay off EE_1 parallel to the current OI so that the line EE_1 will represent the electro-motive force consumed by the resistance ($r = 1$), also lay off E_1E^1 perpendicular to the current and equal to the electro-motive force consumed by the reactance of the line element ($x = 4$).

Then OE^1 will be the voltage at the generating end of the element.

In order to obtain the current at the generating end we draw II_1 parallel to the electro-motive force OE, this represents the current consumed for conductance ($g = 2x10^{-5}$) and I_1I^1 perpendicular to OE represents current consumed for capacity ($b_c = 20x10^{-5}$). Then OI^1 will represent the current at the generating end of the element.

In this way the electro-motive force and current at the generating end of each successive element is found until we read the generating end of the line. This construction gives the circuit characteristic of broken lines due to using finite line elements.

By the differential method these characteristics become smooth curves, as will be shown later.

Having indicated the general solution of the problem by means of the graphical treatment, it now remains to deduce the particular equations for the electro-motive force or current of any alternating-current transmission line. We will have given either the electro-motive force and current of the receiving circuit with their phase difference, or the impedance of the receiving circuit with the generator voltage given. In either case the equation will express the electro-motive force or current of any point of the line.

Assume any point at a distance x from the receiver end toward the generator. The electro-motive force at this point is given by the complex expression, $\dot{E}_1 = e_1 + j\,e_1^1$, and the current by $\dot{I}_1 = i_1 + j\,i_1$

Using the general terms for the line constants already found, for the differential element of the line dx the leakage current is $\dot{E}\,g\,dx$, the capacity current $-j\,\dot{E}\,b_c\,dx$ is $d\dot{I} = \dot{E}\,(g - jb_c)\,dx$.

In the same element the electro-motive force consumed by resistance is $\dot{I}\,r\,dx$, that by reactance $-j\,\dot{I}\,x\,dx$, and the total electro-motive force consumed in the line is:

$$d\dot{E} = \dot{I}\,(r - jx)\,dx.$$

This gives the two fundamental differential equations.

$$\frac{d\dot{I}}{dx} = \dot{E}\,(g - jb_c) \qquad (1)$$

$$\frac{d\dot{E}}{dx} = \dot{I}\,(r - jx) \qquad (2)$$

Differentiate them and

$$\left.\begin{aligned} \frac{d^2\dot{I}}{dx^2} &= \frac{d\dot{E}}{dx}(g - jb_c) \\ \frac{d^2\dot{I}}{dx^2} &= \frac{d\dot{I}}{dx}(r - jx) \end{aligned}\right\} \qquad (3)$$

Substituting (1) and (2) in (3) gives:

$$\frac{d^2\dot{E}}{dx^2} = \dot{E}\,(g - jb_c)\,(r - jx) \qquad (4)$$

$$\frac{d^2\dot{I}}{dx^2} = \dot{I}\,(g - jb_c)\,(r - jx) \qquad (5)$$

the differential equations of $\dot{E}$ and $\dot{I}$.

The integration of these equations is found complete in article 115, page 167, of C. P. Steinmetz's "Alternating-Current Phenomena." Suffice it to say here that these differential equations are identical and, consequently, the functions of $\dot{E}$ and $\dot{I}$ differ only in their limiting conditions, and they are integrated by the general form $\omega = a\,e^{rx}$

$$\text{for } \frac{d^2\omega}{dx^2} = v^2\omega$$

representing for one solution of a complex quantity $a - j\beta$ where

$$a = \sqrt{1/2\left\{\sqrt{(g^2 + b^2)\,(r^2 + x^2)} + (gr - b_c x)\right.} \qquad (6)$$

$$\beta = \sqrt{1/2\left\{\sqrt{(g^2 + b_c^2)\,(r^2 + x^2)} - (gr - b\,x)\right.} \qquad (7)$$

The final integrals become:

$$\dot{I} = \frac{1}{a - j\beta}\left\{\dot{A}\,e^{a\,x}(\cos\beta x - j\sin\beta x) + \dot{B}\,e^{-a\,x}(\cos\beta x + j\sin\beta x)\right. \qquad (8)$$

$$\dot{E} = \frac{1}{g - j\,b_c}\left\{\dot{A}\,e^{a\,x}(\cos\beta x - j\sin\beta x) - \dot{B}\,e^{-a\,x}(\cos\beta x + j\sin\beta x)\right. \qquad (9)$$

where A and B are constants of integration.

It is a point of particular interest that the values of current and electro-motive force seem to follow in a wave that is

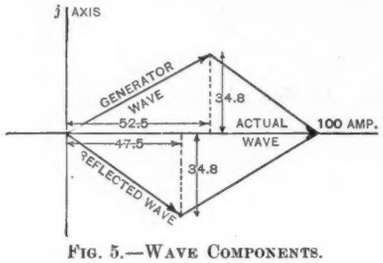


FIG. 5.—WAVE COMPONENTS.

itself made up of two compound waves.

One, with the factor $e^{a x}$, a generator wave, increases in amplitude as x increases; that is, it grows larger toward the generator. The other, with the factor $e^{-a x}$ is a reflected wave and decreases toward the generator.

We may indicate the solution for any particular case by applying the limiting conditions. Thus at the point $x = {}_0$ the above equations become:

$$\dot{I}' = \frac{a - j\beta}{\dot{A} + \dot{B}} \qquad (10)$$

$$\dot{E} = \frac{\dot{A} - \dot{B}}{g - j b_c}$$

It was also assumed that we knew E

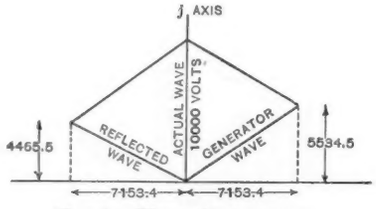


FIG. 6.—WAVE COMPONENTS.

and I at the receiver circuit with their phase relations:

$$\dot{I}' = i_1 + j\, i_1^1$$
$$\dot{E}' = e_1 + j\, e_1^1 \qquad (11)$$

Substituting (11) in (10) we obtain:

$$2\dot{A} = \left\{ (a\, i_1 + \beta\, i_1^1) + (g e_1 + b_c e_1^1) \right\} + j \left\{ (a\, i_1^1 - \beta\, i_1) + (g e_1^1 - b_c e_1) \right\}$$
$$2\dot{B} = \left\{ (a\, i_1 + \beta\, i_1^1) - (g e_1 + b_c e_1^1) \right\} + j \left\{ (a\, i_1^1 - \beta\, i_1) - (g e_1^1 - b_c e_1) \right\} \qquad (12)$$

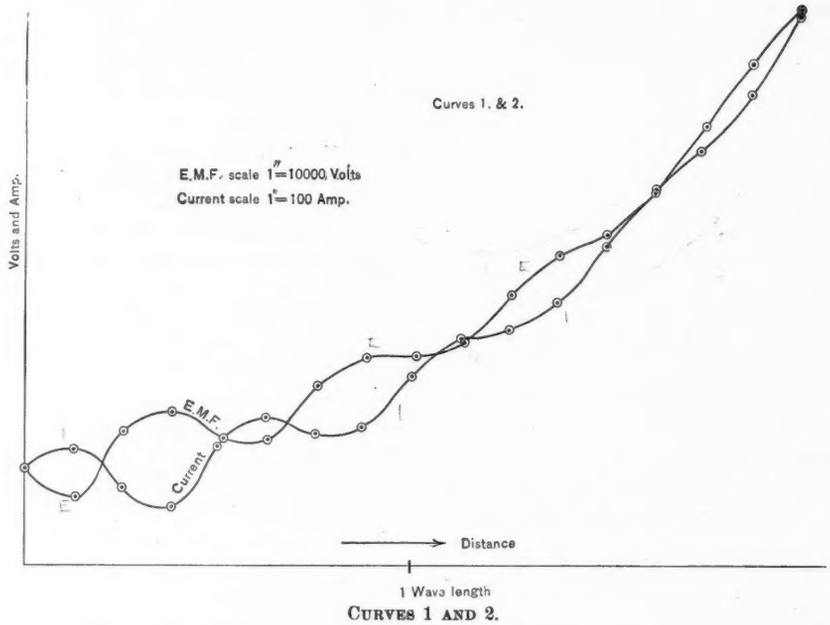
a and β are given by (6) and (7); $i_1\, i_1^1\, e_1\, e_1^1$ by (11), hence all terms of (12) are known, and the constants A and B are determined.

This gives a means of finding by (8) or (9) the current or potential at any point x of a long-distance transmission line.

From (8) or (9) we can observe that when $\beta x = 2\pi$ a complete wave length will then have been gone over, so that gives us $x_0 = \frac{2\pi}{\beta}$ as a complete wave length.

It means that in that distance the phase relation of either the outgoing or reflected wave has gone through a complete cycle and returned to its original position. That is, that the vector has swept around the circle and returned.

This deduces and calls attention to all equations necessary for the solution, and



CURVES 1 AND 2.

we will now apply it to a line of the same constants as was treated earlier by the graphical method.

Data:

$\dot{E}_1 = j\, e_1^1 = 10{,}000$ volts.

$\dot{I}_1 = i_1 = 100$ amperes.

Power factor = 0

r = 1 ohm per mile.

$x = 2\pi f L = 4$ ohms per mile.

$g = 2 \times 10^{-6}$ ohms per mile.

$b_c = 2\pi f C = 20 \times 10^{-5}$ ohms per mile.

$$2.495 - j\, 2.636$$
$$\dot{A} = 1.25 - j\, 1.32$$
$$2\dot{B} = (a\, i_1 - b_c e_1^1) + j\,(-\beta i_1 - g e_1^1) =$$
$$-1.505 - j\, 3.036$$
$$\dot{B} = -.75 - j\, 1.52$$

Substituting in (8) and (9) the general equations.

$$\dot{I} = \left\{ e^{a x} (52.5 \cos \beta x + 34.8 \sin \beta x) + e^{-a x} (47.5 \cos \beta X + 34.8 \sin \beta x) \right\}$$
$$+ j \left\{ e^{a x} (34.8 \cos \beta x - 52.5 \sin \beta x) - e^{-a x} (34.8 \cos \beta x - 47.5 \sin \beta x) \right\}$$

$$\dot{E} = \left\{ e^{a x} (7{,}153.4 \cos \beta x + 5{,}534.5 \sin \beta x) - e^{-a x} (7{,}153.4 \cos \beta x + 4{,}465.5 \sin \beta x) \right\}$$
$$+ j \left\{ e^{a x} (5{,}534.5 \cos \beta x - 7{,}153.4 \sin \beta x) + e^{-a x} (4{,}465.5 \cos \beta x - 7{,}153.4 \sin \beta x) \right\}$$

$$a = \sqrt{1/2 \left\{ \sqrt{(g^2 + b_c^2)(r^2 + x^2)} + (gr - b_c x) \right\}} = 4.95 \times 10^{-3}$$

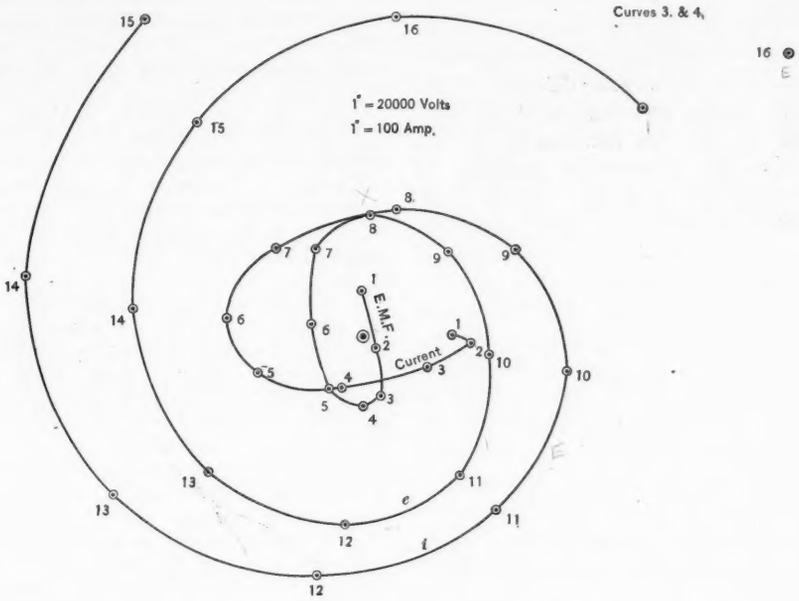
$$\beta = \sqrt{1/2 \left\{ \sqrt{(g^2 + b_c^2)(r^2 + x^2)} - (gr - b_c x) \right\}} = 28.36 \times 10^{-3}$$

$x_0 = \frac{2\pi}{\beta} = 221.5$ miles, wave length.

$2\dot{A} = (a\, i_1 + b_c e_1^1) + j\,(g e_1^1 - \beta\, i_1) =$

These are the general equations reduced by the particular constants to suit our given line. All there remains to do is to

substitute different values of x and obtain the values of the components of both outgoing and reflected waves, which, compounded, give the resultant value both as to intensity and phase.

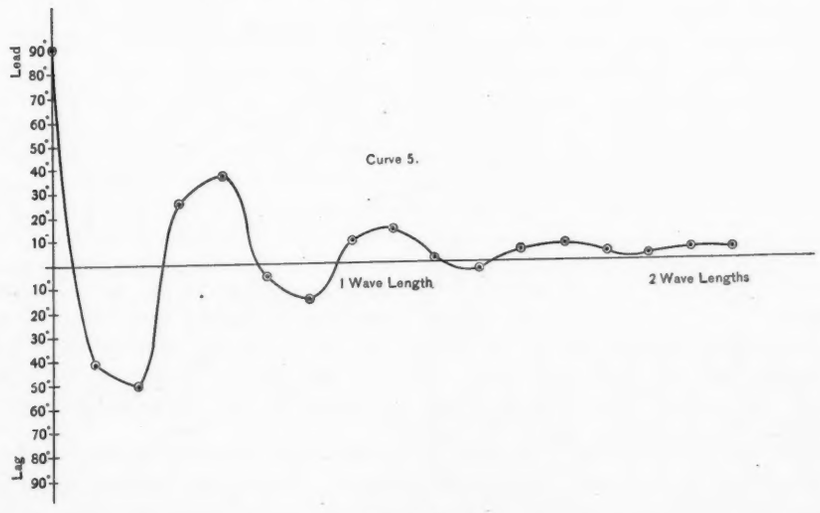


CURVES 3 AND 4.

At receiver end $x =$

$$I = (52.5 + 47.5) + j_0\,(34.8 - 34.8) = 100$$

$$E = (7{,}153.4 - 7{,}153.4) + j\,(5{,}534.5 + 4{,}465.5) = j\ 10{,}000$$



CURVE 5.

In a similar manner to the point $x = 0$ all succeeding points may have similar parallelograms drawn out which will show the position at each successive point of the generator and reflected wave, as well as the resultant or actual value of current or electro-motive force at that point.

CURVES.

Having obtained values of electro-motive force and current, also their phase relations for each eighth of a wave length, we can construct a number of curves.

There are five of these curves. The first two showing the increase of electro-motive force and current, respectively, from the receiver to the generator. In the construction of these curves, distances were taken as abscissas and values of electro-motive force and current as ordinates. The third and fourth curves show the values of electro-motive force and current, as well as their phase relations. The distance of each point from the axis represents, by its direction, the phase, and, by its length, the intensity. This gives a kind of a screw-shaped curve of which the distance along the axis of the screw represents the distance along the transmission line.

The last curve represents the phase relation of electro-motive force and current at different points of the transmission line. In this construction distances are used as abscissas and phase relations as ordinates. The difference of phase toward

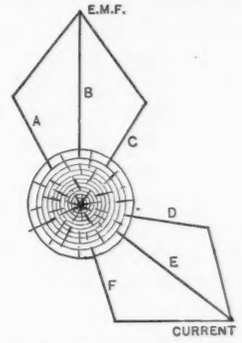


FIG. 7.—DIAGRAM OF MODEL.

which the electro-motive force and current tend at infinity can be found by the formula:

$$\tan \omega a = \frac{-a\,b_c + \beta g}{a g + \beta b_c} = \frac{-42.28}{577.1} = \frac{.0732}{= -4^\circ\ 11'}$$

MODEL OF TRANSMISSION LINE.

The model represents six distinct waves of the transmission line—the incoming electro-motive force and current waves, the reflected electro-motive force and current waves, the resultant electro-motive-force wave, caused by the combination of the incoming electro-motive-force wave and the reflected electro-motive-force wave, and the resultant current wave, caused by the incoming current wave and the reflected current wave. The model was constructed in the following manner:

A cylinder of wood about four feet long by three inches in diameter was used as a shaft. The length of the shaft represents one wave length, and is divided into eight parts. At each of these divisions a copper band was fastened so as to give a means for fastening the parallelograms which represent the electro-motive forces and currents, both with respect to intensity and phase relation. These parallelograms were first drawn to scale, the values used having been obtained by the differential method. By means of these drawings the values of the electro-motive forces, current and their phase relation could readily be seen. These parallelograms

were then constructed of copper wire and fastened to the shaft as shown in the figure.

The centre of the shaft is taken as the point of zero potential and zero current, A represents the reflected electro-motive force, C the incoming electro-motive force, B the resultant electro-motive force, D the reflected current, F the incoming current and E the resultant current.

The lengths of these lines represent intensity and their position the phase relations. The wires A, B, C, etc., were entered into the shaft a short distance and then soldered to the copper ring. The corresponding points of the parallelograms on adjacent rings were joined by large pieces of copper wire and these represent the required waves.

By reference to the accompanying curves it can be seen that even in a line of one wave (220 miles) our values have run up enormously, more than doubled, hence we have before us a picture of the difficulty attending long-distance transmission. One wave length is bad, seemingly practically impossible. If we had carried the solution to two lengths (440 miles) our difficulties would have piled up rapidly, requiring a voltage of over 80,000 volts to give 10,000 volts at the receiver end of the line.

That is the condition confronting the engineer to-day when he tackles a long-distance pole line. The field of improvement is open to all, the need great. Let us hope the engineers of the new century will master the problem so that before the present young generation has passed away we may see the streets and residences of our great metropolis lighted from the terrific energy which so inspires with awe the beholder of that wonder of nature, the cataract of Niagara, 440 miles distant.

The vessels which are now being built by the Eastern Shipbuilding Company, in New London, Ct., for the Great Northern Steamship Company, are to have complete steam and electric laundry plants. These are said to be the first merchant vessels ever equipped with a plant of this kind for use in general service. These laundry plants are being manufactured by the Empire Laundry and Machinery Company, of Boston. Each ship is provided with two large metallic cast-iron and brass washing machines, extractors, manglers, starch kettles, Tyler washers, electric irons, special tanks, washtray sets and other machinery.

Dr. Henry Le Favour has been elected president of the newly organized Simmons College for Women at Boston. Dr. Le Favour is at present professor of physics at Williams College.

British Westinghouse Electric and Manufacturing Company, Ltd.

A number of interesting facts regarding the works of the British Westinghouse Electric and Manufacturing Company, Limited, which are being built at Trafford Park, Manchester, England, are contained in the remarks by Mr. George Westinghouse at the annual meeting of the shareholders of that company. This company has been formed to carry on the manufacture of electrical apparatus to supply the British market. All the British business possessed by the American Westinghouse Company has been turned over to this concern.

Provision has been made for manufacturing engines to utilize gas besides the manufacturing of electrical machinery. It would seem at the present time as though the manufacture of gas engines was to become a more and more important industry, as this method of producing power from coal is believed in some quarters to be more economical than to produce this power by means of the steam engine.

The capital stock of the company consists of £1,000,000 six per cent preferred stock and £750,000 ordinary stock. Already considerable profits have been earned by this company, although the apparatus sold had to be manufactured at the American works and a certain amount of profit allowed to that company. The net result in profits for the past year has been £49,533. This result was reached after liberal deductions had been made from the gross profits for the stock on hand, laboratory tools, fittings, etc., and the expenditures for advertising in its different branches. For the six per cent dividend on the preferred shares already paid up £30,625 is necessary, which leaves a surplus to carry forward of £18,988.

The orders on hand in July, 1899, amounted to £279,000, while those in July, 1901, amounted to £738,000, which shows a most gratifying increase in business, although it has been necessary to carry it on under conditions which were most disadvantageous. A number of contracts are on hand at present, among which is the very important one of electrifying the Mersey railway.

The Traction and Power Securities Company, Limited, which has a nominal capital of £1,000,000, has been formed to take the securities of companies which wish to pay for contracts in that manner instead of turning over the cash. This was the case in the contract for the electrification of the Mersey railway.

The company spent up to July 31, 1901, £433,126 upon its work. In this amount the expense for the land is not included. The land is rented at three and one-half per cent on a price which has been agreed upon and can be purchased at any time within a period of fifteen years. The manufacturing operations at Manchester are expected to begin in the early part of 1902. The buildings are so built that two sides are permanent, while the other two are such that they may be termed temporary. They are built in this way so that they can be extended at any time in case additional space should be required.

Electric cranes are to be used for all purposes wherever possible and the factories are to be equipped with the most modern electrically operated machine tools.

A number of houses for the workmen are being built by the Trafford Park Dwellings Company, Limited, which is an independent company. From 2,500 to 3,000 workmen's dwellings are to be erected. For the foremen some more elaborate dwellings are to be built.

The machine tools required by the company are being looked after by the company's works manager, Mr. H. S. Loud, who has, together with several competent assistants, prepared the plans and is at the present time in Pittsburgh engaged with a large number of mechanics in the preparation of special machinery.

At the present time there are Westinghouse companies in France, Germany and Russia. In this way each company has a separate field of its own and is able to exchange information of value and secure valuable patents wherever they may be found.

Northwestern Electrical Association.

The tenth annual convention of the Northwestern Electrical Association will open in Milwaukee, Wis., on Wednesday morning, January 15, 1902. A number of reports and papers on subjects of especial interest to central station men will be read and discussed. For this meeting an attractive entertainment programme is being arranged and a pleasant and profitable time is assured to all those in attendance. All who are interested in electrical matters are cordially invited by the association to attend the convention.

Throughout New England and in other parts of the country many districts are too sparsely populated to permit of the introduction of the steam roads, but in which the electric roads can operate at a profit. Such districts should not be slow in realizing the advantages to be gained by the introduction of electric railways and should do all in their power to facilitate their construction in the way of granting franchises and rights of way. In nearly every case they have contributed much to the comfort and advancement of the community.

THE CONSTRUCTION OF SMALL TELEPHONE EXCHANGES—XIX.

BY A. E. DOBBS.

(Part II.)

This brings us to one of the most common of all the systems of transposition in use, devised by the American Bell Company on the New York and Chicago circuits (Fig. 84) and still in use through the central states. It is a system that is well balanced every mile of the way (5,200 feet, according to the blue print), and is so simple that any lineman of ordinary intelligence and experience can follow it. It may be well to state that the system was once patented, but whether the patent has expired or whether it is not considered binding, independent companies seem to use it with impunity, so that the writer has no hesitation in giving it in this connection.

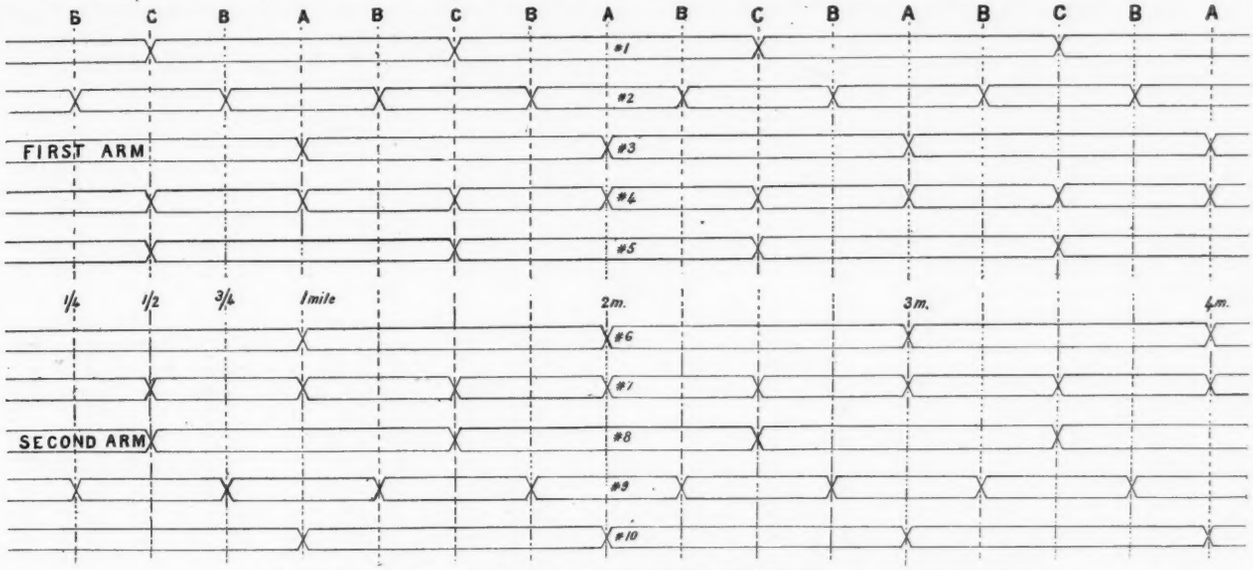


FIG. 84.—TRANSPOSITION PLAN USED ON THE NEW YORK-CHICAGO LINE AND ELSEWHERE.

The reason that the half-mile transpositions are placed in circuits 2 and 4 probably arises from the fact that all these circuits are not often built at one time. Probably one circuit, the "pole-pin" or third circuit, is the first one strung out. This is transposed every mile on the A pole. Should a second be run out, it follows the B transposition points. A third circuit transposes on A and C, while a fourth and fifth are transposed every mile, "breaking joints," to use a bricklayer's term, on C.

As the two end circuits are separated by a distance of 7.5 feet, and the three intervening circuits act as a screen against inductive effects, these two are therefore transposed at the same place, the inductive effects being swallowed up by the other lines. As a second arm is added, the circuits are so arranged as to counterbalance those immediately above them so that the balance is preserved. If a third arm is added it follows the plan of the first arm, while a fourth will follow the second arm transposition, and so on down. This company sometimes uses another and more complicated plan in special cases.

For the sake of showing the possibilities of such a scheme the author gives a plan, shown in Fig. 85, which is irregular enough to suit the traditional "Philadelphia lawyer," but in certain situations may possess distinct advantages of its own and can be used in connection with either of the arms shown in Fig. 84, where it may be desirable to break up inductive effects more thoroughly. The plan given is carried out for eight miles to illustrate it more clearly.

FIG. 85.—IRREGULAR TRANSPOSITION—THE LETTER N PLACED BETWEEN TWO CIRCUITS SHOWS THE POINTS OF BALANCE.

First, Nos. 1 and 5 are transposed every fifth section, or one and one-quarter miles.

No. 2 is transposed ever third section, or three-quarters of a mile.

No. 3 crosses every mile, while No. 4 is an irregular circuit, crossing first every three-quarters and then one-half mile.

Now as to the neutral or balancing points of these circuits:

Beginning with Nos. 1 and 2 and counting from the left we find at the first transposition point of No. 1, which is one and one-quarter miles from the office,

3 sections in unison,
2 sections in opposition.

There is therefore no balance in this section, but by following No. 1 to the next transposition we find,

2 sections in unison,
3 sections in opposition,

making a total of

5 sections in unison,
5 sections in opposition,

at a distance of two and one-half miles from the office at the point N. One mile further, or three and one-half miles from the office, we find another spot at which these two circuits balance each other. At three and three-quarters miles both are transposed but they do not strike another balance until the sixth mile is reached, while in the succeeding mile they balance again, after which they do not even up for three and one-half miles, or ten and one-half miles from the office.

As against No. 3 circuit it is not necessary that there should be such frequent balances, due to the distance between the two circuits and the screening effects of No. 2, so that the balance comes every five miles. No. 5 also balances against No. 3 in the same way. In regard to

No. 4 we can not make that a three-section transposition, owing to the fact that it would never balance against No. 2, no matter how arranged, therefore we break it up by transposing first at the third section and then at the second, or the order can be reversed if desired. In this way it balances against No. 5 every two and one-half miles; against No. 3 at two, three, four, five, seven and eight miles; against No. 2 it is less regular, the balances being at four and one-half and seven and one-half miles.

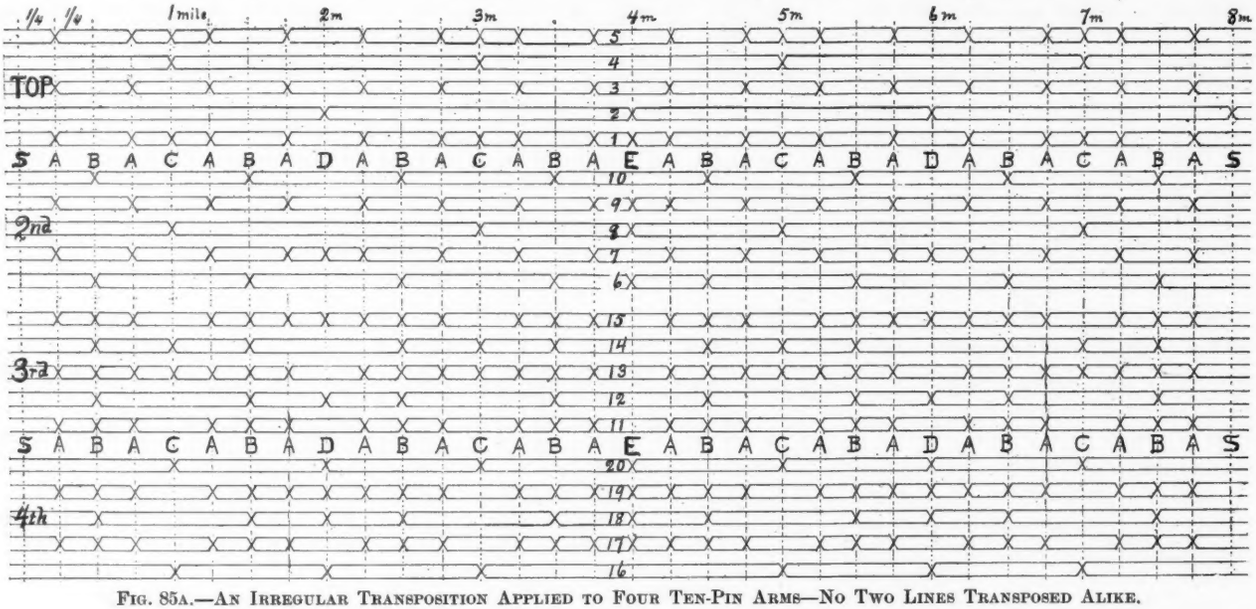


FIG. 85A.—AN IRREGULAR TRANSPOSITION APPLIED TO FOUR TEN-PIN ARMS—NO TWO LINES TRANSPOSED ALIKE.

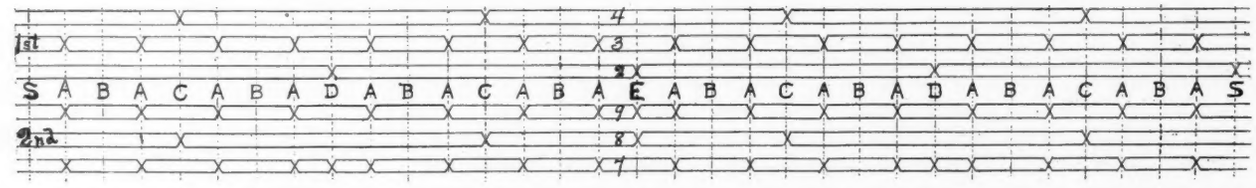


FIG. 85B.—THE SAME TRANSPOSITION APPLIED TO TWO SIX-PIN ARMS—THEY ARE NUMBERED THE SAME AS AN UNCOMPLETED TEN-PIN ARM.

This system, however, will never be popular except in special cases for the reason that the whole route would have to be plotted out in advance of construction and some extra transpositions cut in in order to balance the lines at the ends.

GENERAL REMARKS.

Sometimes, for some special reason—as, for example, the proximity of a trolley road or electric light circuit—it may become necessary to break up these transpositions into shorter lengths than those regularly shown. That being the case, the transposition can be divided into halves or quarters just as well as not, provided that all the other circuits are divided in like ratio into halves or quarters, but to divide one of the circuits without dividing the rest would make trouble, as it would disturb their relation to each other. There is one exception to this, however, in the making of two transpositions in the regular distance instead of one. Let us suppose, for example, that in Fig. 84 it was thought desirable in passing through a town to divide circuits No. 1 and No. 5 at every quarter of a mile instead of every mile, as shown. If this should be carried out for one mile we would have three extra transpositions which would unbalance the line; if, however, we should carry this out for two miles, we would then have six extra transpositions instead of three, which would then leave the wires in the same relative position as before.

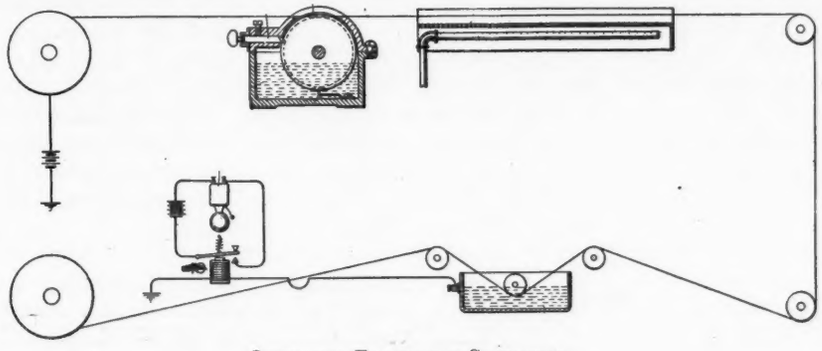
When changes of transposition are confined to one or two lines, make the number of the extra transpositions divisible by two. Keep the transpositions as nearly as possible at equal distances apart.

Do not make transpositions except at the places indicated. Sometimes young linemen get it into their heads that as transpositions are a good thing you can not have too many of them, and will, therefore, make them at undesirable places. On one occasion that came under the writer's observation there was a telephone station cut in on a line between two transposition poles. For convenience in testing both lines were looped into a switch in the station. In connecting to the inside wires the lineman cross-connected his circuit in such a manner that there was a transposition at this loop. It took two inspectors three days to find out what was the matter with that line, for the line, when tested, was perfectly quiet both sides of the station.

Attempts have sometimes been made to reduce cross-talk on grounded lines by transposing them from one end of the arm to the other, from the middle to the outside, etc., but such plans are of doubtful benefit and do not repay the trouble had in keeping a record of the wires, to say nothing of the fact that the inspectors can never tell where to find them except by testing. In regard to the plan in Fig. 85, it might be added that previous to bringing these wires into a terminal station the plans of transposition should be so altered as to retain a balance from the last balancing point, either by transposing every half mile or otherwise. Suppose two of these lines should balance against each other every five miles and the terminal station should be placed at, say, eighteen miles, which is not a multiple of five. This would, unless changes were made, create a length of three miles on the end that would not be balanced against the rest and changes should be made accordingly.

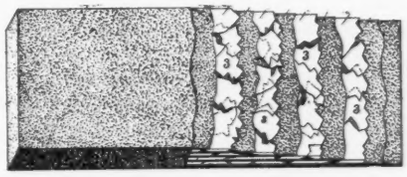
Electrical Patents

The General Electric Company has purchased a patent just issued to Messrs. Wallace S. Clark and George H. Rupley, residents of Schenectady, N. Y., on an insulated electric conductor and the process or method of making the same. The object of the invention is to manufacture a conductor covered with a dense coherent and elastic insulating material which may be applied so as to envelop the conductor when desired in a thin skin or volume. As a result, the manufacture is greatly cheapened and the insulating properties are enhanced, while the space occupied by the insulation is reduced. In carrying out the invention there is placed upon the conductor a uniform coating containing a compound of an amorphous or structureless cellulose and its drying is retarded after being applied to the conductor, thereby ensuring a uniform thickness of the film or coating and intimate and uniform adhesion between the coating and the surface of the conductor; also, a toughening of the covering and absence of cracks due to uneven shrinkage. There is employed a soluble compound of cellulose, to which is added a vehicle, which will combine with the solvent, of slow-drying or evaporating qualities relatively to the solvent and the ingredients are mixed in such proportions as to form a compound fluid at the working temperature and lead the conductor into contact with the compound, whereby the latter is covered with a thin film, and as it is lead away from the bath or coating apparatus the coating is evenly distributed around the conductor and the latter then lead through a drying apparatus and wound upon a reel. The best results have been obtained thus far by employing a solution of pyroxylin in methyl alcohol, to which sufficient amyl acetate has been added to retard the drying. If the alcohol alone be employed as a solvent its highly volatile character does not permit an effective application of the amorphous cellulose compound to the conductor and leaves the coating in a poor condition to withstand service. A rapid drying tends to crack the coating, leaving it valueless as an insulating medium, particularly where exposed to water or damp air, and leaves it brittle and liable to crack and chip off under flexure of the conductor. The addition of the amyl acetate adds toughness to the coating and gives it an elasticity which prevents cracks in drying and permits it to withstand bending of the conductor. The invention, however, is not limited to the application of a solution of pyroxylin, but includes also other amorphous compounds of cellulose known to the arts, or pure structureless cellulose derived from cotton or other vegetable fibre, the essential feature of the invention being the application of a solution of an amorphous cellulose compound in such a way as to render the compound non-brittle when dry. The invention may be carried out by the employment of a variety of apparatus; but the form found to be effective in practice comprises a bath of coating material in which revolves a grooved wheel to pick up the insulating material, the top of the groove projecting above the bath and devices for leading the conductor tangentially to the groove. By this organization good distribution of the coating material on the conductor is effected. The conductor is led to the grooved wheel from the supply-reel, and after being coated is carried through a drying-box or chamber, and then passes through a testing-bath for locating any defective spots in the insulation, after which it is wound upon a receiving-reel ready for shipment.



Insulated Electrical Conductor.

A form of insulating material was patented recently by Mr. Charles W. Jefferson, of Schenectady, N. Y., who disposed of his entire interest to the Mica Insulator Company, of New Jersey. In the present case, the invention relates to composite insulating material, and the aim is to provide a flexible and non-brittle body which will resist a very high electrical voltage, and withstand a very great degree of heat. Electrical insulators have been made in the shape of plates or sheets and of some comminuted or pulverized non-combustible insulating material mixed with a hardening cement. One of the disadvantages of this kind of insulator is that it is not pliable and that it is brittle and also that it has not the required efficiency as to insulation and durability, and the plates or sheets so made being brittle and non-pliable are more apt to chip and break when being manipulated or cut into smaller pieces for insulation. In order to remedy these defects and to give the sheet more durability and flexibility, sheets of fabric have sometimes been introduced into the combined insulating sheet or plate; but the disadvantage of the use of such fabric is that it is readily carbonized, and as soon as this happens the efficiency of the insulator is impaired. Sheets of insulating material have also been made from layers of scales of mica cemented by a varnish and then the sheet so formed dried by steam and then subjected to intense pressure, so that the varnish between the mica scales and between the layers will be expelled, leaving only sufficient of the varnish to cause the mica scales to adhere together. The plate or sheet so formed is then subjected to intense pressure, so that the different layers of mica scales are formed into a compact sheet in hard state. A sheet of insulation constructed as above described makes a very good insulator; but as the sheet itself is virtually composed of a solid mass of mica it is somewhat brittle and not as pliable as is sometimes desired. Also with such a construction of insulating sheet it is liable to crack, especially when cut into smaller pieces or trimmed. By this invention a very simple, inexpensive, pliable, non-brittle and highly efficient insulating material can be constructed. The method preferably used in the manufacture of the improved insulating material is as follows: A layer of insulating material in a fluid or semi-fluid state is first applied to a base-plate, said plate having previously been coated with soapstone or some similar material, so that



New Form of Insulating Material.

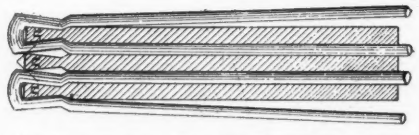
after said layer has become hardened, or partly so, it may be readily scaled from the plate. The material which is generally used is an oxidized oil, and preferably oxidized linseed oil, as such oxidized oil forms in itself a very good insulator and is quite pliable when oxidized or dried. In order to produce the best results, linseed oil is taken, which has first been oxidized, and it is then dissolved with benzine or some similar solvent. To this dissolved oxidized oil is added a very small proportion of some gum, as copal gum. This gives the oil a little more of an adhesive quality and a little more body. After the liquid above described is applied in a layer to the base-plate, as above stated, a layer of mica scales is laid on the layer of said liquid, preferably overlapping each other, then another layer of the liquid is applied over the layer of mica scales, and this process is continued until the sheet is of the desired thickness, said sheet being made of alternate layers of the insulating liquid or semi-liquid and of mica scales. When the sheet is of the desired thickness, the plate is then heated, preferably by steam from a pipe. The highly volatile quality of the benzine or other solvent will have caused it to evaporate to some extent even before the plate is heated, thus turning the oil or other liquid into a gum, uniting the different mica scales and layers of the same. The heat from the plate will cause still more evaporation of the solvent and tend to dry the oxidized oil. During said evaporation and drying, while the sheet is still upon the plate, a light pressure is applied to the sheet by means of a roller or other device, such pressure being sufficient to smooth and level the layers of oxidized oil and mica scales and to expel the gas from the sheet; but such pressure must not be sufficient to squeeze out the oil or other binding compound, as such oil, which is now transformed into a gum, is to constitute the main portion of the insulating sheet. The sheet is then put in an oven for a short time and dried. It is then taken out of the oven and coated by dipping or otherwise in the dissolved oxidized oil or other liquid, thus forming a coating or cover to the sheet, and then hung up in the oven—say, with a temperature of about 100 degrees Fahrenheit—for about two hours, with a heat gradually increasing to about 400 degrees Fahrenheit. The temperature of the oven is then gradually reduced for about two hours to about the degree of heat that the plate first became subjected to, which might be in the neighborhood of 100 degrees Fahrenheit. The oxidized sheet is now complete, and it is of a very pliable character, with the oxidized and baked oil forming the main part or body of the sheet filling in all the spaces between the mica scales and between the layers of the same, and uniting said scales and layers so that the completed sheet is formed in one solid mass. The insulating sheet made by the improved method has been found to be the most efficient as an insulator, and it will withstand a very high degree of heat and also a very high electrical voltage, higher than that of any compound insulating materials so far known. By practical experience it has been found that the insulators made in accordance with this invention will resist at least 1,500 volts to one-thousandth of an inch in thickness of said insulators.

Two Germans, Herren Josef Franz Bachmann and Adolf Vogt, of Vienna, Austria-Hungary, have been working for

A Novel Resistance.

some time on a novel form of resistance which is composed of a mixture of refractory non-conductive material, such as an artificial stone compound, with a conductive material, such as carbon. They are now making use of this idea, as is evidenced by the patent just issued to them, and assigned to the Electric Resistance and Heating Company, Limited, of London, England. The invention has for its object a resistance of annular or ring form of substantially uniform cross-sectional area of regular or irregular form in cross-section, the conductivity of which decreases in a circular direction from maximum to minimum, in combination with an electric contact arranged to trail over the face of the resistance. The invention has for its further object the provision of means for cutting the resistance out of the circuit and the provision of means for short-circuiting the resistance. The resistance is composed of a mixture of a non-conductive artificial stone compound with a conductor of electricity, such as carbon, and is prepared by mixing the conductive and non-conductive constituents together with water or other suitable liquid to adapt the composition for moulding or casting, the proportion of conductive material of the successive sections being decreased according to the desired proportional successively increasing resistance, the part O being that of least resistance. The moulded resistance is then dried and heated to a high temperature either while embedded in carbon or in the presence of a reducing gas. With an annular resistance, such as described, there is employed a revoluble electrical contact arm, and it is obvious by connecting the part O of least resistance and the contact arm, either through its pivot or otherwise, with the circuit-terminals and rotating said arm over the resistance, the resistance to the passage of the current can be increased from minimum to maximum, and *vice versa,* at will. If in the use of the resistance it is desirable or necessary that means should be provided for cutting it out of the circuit, there is interposed between the parts of minimum and maximum conductivity an insulation, which may be of any desired character—as a segment of marble, slate or the like—and for the purpose of preventing sparking and injury to the sliding contact surfaces on the opening of the circuit by the moving of the contact arm on to the insulation, a metallic resilient contact is provided, secured to the part of maximum resistance to electrically connect the arm with the resistance.

Mr. C. S. Kaufmann also patented an insulator for storage battery plates. The object of the invention is to construct an insulator for use in maintaining the sep-

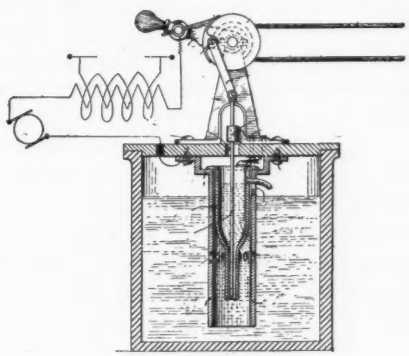


Insulator for Storage Battery Plates.

aration of the plates of an accumulator or storage battery which can be easily manipulated and will be found efficient under all circumstances and not liable to ride the plate or become easily displaced in the handling and use of the plates and battery; and the invention consists in the features of construction and combination of parts hereinafter described. The insulator is made of vulcanized rubber, gutta-percha or other suitable insulating material and is formed with an engaging head or neck and two legs or members, joined or united to the head or neck. The head or neck is formed of a top or cross piece and side pieces, inwardly converging and terminating in a shoulder at the juncture with each leg or member, and each shoulder has a slight outward flare. The legs or members extend from the shoulders, so as to stand parallel, or approximately so, one with the other when the insulator is detached. The legs or side members, with the sides of the neck of the insulator, as a whole, approach most closely one to the other at the shoulders so that the forma-

tion of the neck is such as to leave an opening of a keystone shape. The distance between the legs at the mouth of the opening is slightly less than the thickness of a battery plate or of the frame for the plate, so that when the insulators are slipped on over the heads or support of a plate the contact at the shoulders causes the legs or side members of the insulators to be thrown outward. The insulators are to be used in a battery by slipping one or more of them over each plate, so as to have a leg or side member of insulator on each side of the plate. The initial or first plate has slipped thereonto two insulators, one at or near each side edge of the plate, the second plate has one insulator slipped thereonto, at or near the centre of the plate, and the third plate has two insulators thereon, as in the first plate, giving an alternating of two and one insulators for each two adjoining plates, which arrangement can be continued for any number of plates. This alternating arrangement of two and one insulators for adjacent plates gives a bearing for each plate at three different points, one at or near each side edge and one at or near the centre, by which the parallelism of the plates is maintained and the plates are held apart uniformly. When an insulator is slipped onto a plate its legs or members are spread or thrown apart at the bottom or lower end, and when the next plate is brought against the preceding one the leg or legs of the insulator or insulators on the preceding plate will be forced and pressed tightly against the plate, and such forcing and pressing of the leg of each insulator inward will cause the shoulder or point of contact to be firmly compressed against the head or neck of the plate, thus preventing any slipping of the plates or of the insulators, producing and maintaining a separation and insulation of the plates in a manner and by means which will be thoroughly effective.

Mr. John O. Heinze, Jr., of Revere, Mass., has patented a novel interrupter for use in connection with induction coils or transformers, the main object being to vary the strength of the current. Within a jar of any suitable material is contained a solution of acid and water. Closing the top of the jar is a cover, to which is secured by screws a lead cylinder provided with suitable openings which provide a free circulation of the solution. Located within the lead cylinder and supported therein near its top is a glass tube having a circular flange, which rests in the upper portion of the lead cylinder on the shoulder. Located centrally within this glass tube is a platinum wire which extends upwardly through an opening in the cover, and at its upper end is pivotally connected to a link, which, in turn, is pivotally connected to a crank-pin on a metallic segment secured on a portion of the circumference of a drum of insulating material. This drum in turn is secured fast to a shaft, mounted in a support secured to the cover, and secured fast to the shaft at the opposite end is a driving pulley. Freely mounted in the shaft is an arm, having a handle and adapted to carry the brush-holder carrying a brush suitably insulated from the arm. In use, the interrupter is connected with the primary circuit of the coil. The lead cylinder forms one part of an electric circuit and the platinum wire forms the other part. The electric current passes to the lead



LIQUID INTERRUPTER.

cylinder through the liquid to the platinum wire and to the primary of the coil, returning thence to the main line. As the wire moves through the glass tube into the liquid and out again it makes and breaks the electric circuit. The size of the platinum wire and the length of its insertion into the liquid and the resistance of the solution and the surface of the lead cylinder determine the amount of current which may pass through the interrupter. The platinum wire is connected to the crank-disc and crank-pin, which in its revolution upon the shaft moves the platinum wire vertically up and down, and by the great number of oscillations of this platinum wire the current becomes steady or uniform—that is, practically continuous in its effect. Attached to the shaft is a drum of insulating material having upon its circumference a metallic segment and mounted free on the same shaft upon which this drum and segment rotate is an arm which may be moved by hand upon the same axis and carries a brush which is insulated from this arm. One end of the electric circuit is connected to this brush. The action of this brush is that as the segment rotates it comes in contact with the brush and so completes the electric circuit through the platinum wire. As the brush is moved around the circumference by hand it comes in contact with the segment when the platinum wire projects variable lengths out of the glass tube, and by this action the current is changed in intensity—that is, when the platinum wire is farthest in the solution the current is the strongest and as it recedes it becomes weaker, so that by the movement of this handle and brush the amount of current thus sent through the primary is varied. The action of this interrupter is that the induced currents by the movement of the brush become stronger or weaker, and so in the manipulation of the X-ray tubes in which the interrupter can play a part the current can be made stronger or weaker, according to the amount of light desired from the tube. With the machine in its normal position, as shown in the accompanying illustration, with the belt running, the current is in its weakest condition, and as the brush-holder is moved to the left the current becomes stronger because the brush makes contact with the segment in the position when the platinum wire is inserted into the liquid to a greater or less degree beyond the tube. A number of these platinum wires, with the cooperating elements, can be arranged in the same jar, so that a greater number of interruptions can be produced without any more speed than that of a single one. With two platinum wires connected to the same shaft and so arranged that one is out of the solution and the other is in, with the same number of revolutions of the shaft, the double arrangement would give twice as many interruptions as a single one.

In the southern part of Illinois an electric road which possesses several points of interest is being built in the coal regions. This road is designed both for freight and passenger traffic. It is known as the Belt Electric Railway, and is located in Williamson County. It is built with a standard gauge and a substantial road-bed. Sixty-pound rails are to be used in its construction. Part of the railway has been in operation for three months and has done a good business in carrying miners to and from the mines. The company plans to put on freight cars eventually, but has only passenger equipment at present. This road forms a loop line from Johnson City *via* Spillertown, Marion, Carterville and Herin and thence back to Johnson City.

THE CRAWFORD-VOELKER INCANDESCENT ELECTRIC LAMP.*

BY F. Z. MAGUIRE.

For three years the Crawford-Voelker Laboratory has been at work endeavoring to produce a new and more economical electric lamp, utilizing the rare earths. This work having been accomplished, the writer is privileged to give for the first time some account of this invention, together with some of the advantages which are likely to result therefrom.

Engineers have for some years claimed that the limitation of carbon as applied to filaments in incandescent electric lamps has been reached, and many inventors have been seeking other material out of which to produce filaments which would give a higher degree of efficiency. It seems somewhat strange that the dynamo has attained such a high state of efficiency, and that the electric incandescent lamp of commerce practically remains where it was ten years ago. The claims of manufacturers to the production of incandescent lamps of low wattage are all discounted, and it is well known that the initial wattage of electric lamps averages, in this country, from four to five watts per candle-power, and even more. When we come to consider the electric lamp of 200 volts and over, we find still greater inefficiency, and Professor Ayrton, F. R. S., past-president of the Institution of Electrical Engineers, at a Board of Trade enquiry held last March, stated that 200-volt lamps were very bad, even when made by the best known manufacturers, and gave the results of some comparative tests showing the mean efficiency at starting of seven watts per candle-power in four groups of twenty lamps each. Sir William H. Preece, K. C. B., F. R. S., etc., has also made tests of lamps of 200 volts openly purchased from four different leading concerns, and states that their mean efficiency was, at starting, 4.21 watts per candle-power, and at 400 hours 5.74 watts per candle-power. The results, as shown, furnish an explanation for large electric light bills, and also for the fact that electricity is not a more vigorous competitor of gas.

The average consumer of electric light is perfectly willing to use an old blackened lamp that is giving little or no illumination, on the theory that it will do fairly well. He gives no heed to the fact that this lamp is costing twice as much money to run as a new lamp. It is also true that there are lamps on the market at the present time such that it would be better for the consumer to pay money to the salesman to take the lamps away rather than to use them; in other words, the cost of the lamp itself is but a small factor in the cost of lighting. It is the consumption of energy that costs the money.

The beauty and healthfulness and superiority of the electric lamp over gas are unquestioned, and yet people still continue to use gas with all its disadvantages, because electric light remains too expensive; hence it is with every good reason that many inventors in the electrical field have sought to improve the lamp by the utilization of new substances which would produce higher economies.

The Crawford-Voelker incandescent electric lamp is the invention which is being brought forward at the present time with claims which are most interesting to electric supply corporations, as well as to the individual consumer. The lamp is the invention of William Lawrence Voelker, and he has been working upon it since 1897.

Colonel H. C. L. Holden, F. R. S., M. I. E. E., superintendent of the Royal Arsenal at Woolwich, who is well known for his work in connection with registering electrical measuring instruments, has made a series of tests of this lamp covering a period of 1,000 hours.

RESULT OF TESTS.

Watts per candle at start	2.535
Watts per candle after 500 hours	2.845
Watts per candle after 1,000 hours	3.35

Putting the tests of Sir William H. Preece with the lamps of various manufacturers against these figures, we find that the Crawford-Voelker lamp shows at the start an economy of 39.8 per cent; after 500 hours of burning, as compared with the 400 hours of burning for the lamps used in Sir William Preece's tests, there is 50.4 per cent economy. Sir William H. Preece discontinued his test after 400 hours, because the lamps he purchased were running so high in wattage as to make them uneconomical for further use. The Crawford-Voelker lamps, however, continued through the 1,000 hours' test, and at the end of that time showed 41.6 per cent economy over Sir William H. Preece's test of only 400 hours.

Mr. Thomas A. Edison, a number of years ago, was engaged upon an attempt to further improve the efficiency of the carbon filament, and stated that Professor Marx, who was at that time the head of the Edison Illuminating Company of Philadelphia, had told him that if a sixteen-candle-power incandescent lamp could be made that would run twenty to the horse-power, he could pay ten per cent dividend on the capitalization of his company, and compete with gas at seventy-five cents (three shillings) per thousand feet; in other words, an improvement on the maximum efficiency of the best present lamp of thirty-three and one-third per cent would enable the electric supply companies to compete with gas. Mr. Edison, in common with a number of others who have attempted to improve the carbon filaments, as a matter of fact has failed up to the present time, in general practice, to get beyond thirteen to fourteen lamps to the horse-power. The Crawford-Voelker lamp already represents, on the basis of the Holden tests, twenty-one to twenty-two and one-half lamps per horse-power, which makes the proposition still more interesting.

The inventor of the Crawford-Voelker lamp claims to have discovered a method of effecting a chemical union between several rare metals or earths and carbon, thereby being enabled to produce for the first time a *true carbide filament.* The filaments made under the new process possess a higher specific resistance than carbon filaments, seem to disintegrate or waste away much more slowly, and are practically uniform in their resistance.

It is also interesting to note that lamps running to such high voltages as 500 volts have been successfully made by this new process, and do not seem to possess the same delicacy that the ordinary 200-volt lamp of commerce shows. These high-voltage lamps are to be seen at the Crawford-Voelker Laboratory, and it may be noted that they can be snapped on and off and show less evidence of vibration than does the ordinary lamp of 200 volts.

The maximum pressure allowed under the regulations issued by the Board of Trade in this country is fixed at about 250 volts, but the difficulty hitherto experienced in obtaining efficient and economical lamps of this voltage, which would have a life long enough to satisfy the users, has practically deprived the supply companies from availing themselves of the manifest advantages of the pressure already allowable.

An interesting feature of the new lamp will be noted in the illustration, which shows that it is bifurcated at the end. The purpose of this bifurcation is to insulate the two ends of the filament. Sir William H. Preece, in March, 1885, presented to the Royal Society a paper "On a Peculiar Behavior of Glow Lamps When Raised to High Incandescence." It shows that as the voltage applied to glow lamps increased, a current flowed through the exhausted space between the heels of the

* From London *Electrical Review*, December 6, 1901.

filament without passing through the filament at all, simply wasting energy. This can also be readily shown by means of a laboratory experiment, which demonstrates the flowing of the current between the ends of the filament. The advantage of this bifurcation has been demonstrated by numerous tests on the part of the inventor, and has proved that the life of the filament is greatly enhanced by the division of the globe. For high voltages it is claimed to be essential.

It would seem, therefore, that electric lighting, through this most important discovery which has been tested very thoroughly for the past fourteen months in this country and in France, is about to come into a new era of prosperity, and that the gas companies will have to look to their laurels, because for the first time electric light has reached a basis where it can compete successfully with gas. In addition to the tests of distinguished experts, both here and in France, in connection with the Crawford-Voelker lamp, many of these lamps have been given to consumers for test, and the testimony concerning their usefulness is a verification of the economies claimed.

In the tests made by Colonel Holden he was not content to use a constant voltage, but submitted the lamps to a street circuit, which was close to the power-house, and the lamps were subjected to the fluctuations due to this close proximity. Since the date of the tests, constant improvements have been going on at the Crawford-Voelker Laboratory, and even greater efficiencies are shown. The laboratory has turned out over 200,000 filaments, and makes the lamp from beginning to end, with the exception of the base.

In making the base, for high voltages porcelain is used; for low voltages a division of porcelain is made in the centre for the purpose of continuing the insulation through the base of the lamp.

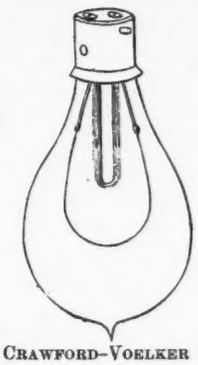
The results herein mentioned refer alone to the carbide of titanium. The experiments of the Crawford-Voelker Laboratory already show that a number of the rare earths other than titanium produce just as interesting results, but have not been worked out to the same extent commercially. Combinations with no less than five different rare earths have been made, some of them giving exceptionally beautiful and interesting results, and may mean more for the future of the electric lamp than even the results herein mentioned.

In the writer's opinion the importance of this invention can not be over-estimated. It is not within the province of this article to discuss the field open to a lamp of this nature, but it is a matter of common knowledge that any improvements in the present incandescent lamp which will make electricity a more active competitor with gas have a field which is practically unlimited, and will also be a great public benefit.

For the benefit of engineers desiring details of the Holden test, extracts from the report of Colonel Holden are appended hereto:

REPORT BY COLONEL H. C. L. HOLDEN, F. R. S., M. I. E. E., ON CRAWFORD-VOELKER LAMPS.

In compliance with your request of December 6, 1900, I have been since that date investigating the advantages and watching the behavior of the Crawford-Voelker lamps. . . . I instituted a test of fifty lamps, which was started on February 27, 1901, and continued without a break, except



THE CRAWFORD-VOELKER LAMP.

to allow of the lamps being measured electrically and tested photometrically, for 1,000 hours.

Eleven lamps out of the fifty broke in the first 500 hours; of these the average life would be about 350 hours. During the second 500 hours, fifteen lamps broke; their average life was 762 hours. The average life of the eleven and the fifteen would thus be 588 hours, and if we take with these the twenty-four which burnt 1,000 hours, the minimum average life of the fifty lamps would be 787 hours.

The instruments used were carefully checked from time to time, and were correct to the Board of Trade standard; the continuity of the tests was assured by a recording voltmeter and also a recording ammeter being included in the circuit. The whole of the lamps tested were not only measured by me personally, but were under lock and key and also under my seal in the cellar in which they were kept under test.

The photometer used was of the Lummer-Brodhum pattern, which is as accurate and reliable an instrument as can be employed for such a purpose, and the standard of light was furnished by a Hefner-Alteneck lamp burning amyl-acetate and emitting a light equal to 0.88 of what is known as the English standard candle; every care was taken by testing lamps on other photometer benches besides this one that no error crept in. The results have been corrected on the basis of the English standard candle. . . . The efficiencies work out as follows: At starting the Crawford-Voelker lamps had an efficiency of 2.535 watts per candle; at the end of 500 hours the Crawford-Voelker lamps had an efficiency of 2.845 watts per candle; and at the termination of the test after 1,000 hours the Crawford-Voelker lamps had an efficiency of 3.35 watts per candle. . . .

The results of Sir Wm. Preece's test are as follows:

The best eight-candle-power lamps (200 volts) obtainable start at an efficiency of 4.21 watts per candle, and have, after 400 hours' burning, an efficiency of 5.74 watts per candle. . . .

The economy, therefore, shown by the Crawford-Voelker lamps over the others is thus 39.8 per cent at starting, and after 500 hours (as against 400 hours of the other lamps) 50.4 per cent; and even if we compare the efficiency of the Crawford-Voelker lamps after burning 1,000 hours, when it was 3.35 watts per candle, they show a superiority of 41.6 per cent, which is a very remarkable result.

I have no doubt whatever but that when these lamps have passed from the laboratory stage to that of the factory, and I see no reason why they should not be manufactured in any quantities as soon as the requisite facilities have been provided. . . . Their already high efficiency, compared to other lamps, will be still further improved. . . .

These remarks are specially applicable to the 200-volt lamp. . . . As regards Crawford-Voelker lamps of lower voltages—100 volts, for instance—there is no difficulty whatever in their manufacture . . . and I see no difficulty in producing Crawford-Voelker lamps of high efficiency up to 400 volts, or even more.* . . .

New Acetylene Generator in Sweden.

The following has been sent by United States Consul Robert S. S. Bergh, at Gothenburg: Mr. Erik Cornelius, chemist at the carbide factory at Trollhättan, Sweden, has invented a new acetylene gas generator, called the "Trollhättan."

This generator is said to be much simpler in construction than former ones, and occupies little space. The falling of the carbide into the water is automatically regulated by a rubber ball, which, as soon as it is filled with gas, closes the valve between the carbide and the water. When the volume of gas decreases, the hollow rubber ball contracts and the feed valve again permits the carbide to drop. The gas is stored partly in the rubber ball and partly in the space between the funnel-shaped carbide magazine and the water. If much gas is generated, the water is pressed through valves into the water-jacket in the sides of the apparatus, thus furnishing more room for the gas. A separate gas tank is therefore not needed. Should too much gas be produced, water and gas escape through a safety valve. Common carbide it used; no cartridges. The gas is dried by being allowed to pass through the carbide magazine, where the carbide absorbs the moisture. As there is no gas tank, and the quantity of gas stored thus is insignificant, it is considered that the fire insurance companies will, without raising the insurance premiums, approve of the apparatus, even when it is placed in dwelling-houses.

*Since this report was written my prediction has been verified, and Crawford-Voelker 500-volt lamps are an accomplished fact.

NOTES ON X-LIGHT.

BY WILLIAM ROLLINS.

NOTE CXXXIII—ON THE THEORY THAT X-LIGHT IS A FLIGHT OF CHARGED PARTICLES.

It is well known that a number of physicists believe that X-light is either a flight of particles of electricity or of matter, shot from the target of an X-light tube. I have already described a considerable number of experiments which appeared to support the theory advanced in these notes that X-light was an ether phenomenon, and now mention an experiment which seems adverse to the theory that X-light is a flight of particles. I made a condenser of 500 sheets of aluminum and caused the X-light to pass through it. Then I measured the intensity of the transmitted light and charged the condenser. The intensity of the light was then measured again and found to be unchanged. Suppose the light had been a flight of particles of negative electricity or of matter charged with negative electricity. When these particles struck the first layer of aluminum, which had a positive charge, they would have been neutralized. If any had gotten through the metal it would have encountered a negatively charged second sheet of aluminum. Their velocity would have been reduced and their direction of motion changed from forward to backward. If any escaped this second layer they would have struck next a positively charged surface, meeting the same reception as at the first. These results would in turn have been repeated through the pile. It is not reasonable to suppose that by the time the particles had passed through 500 layers of charged aluminum foil their number would not have been diminished and the light have become less bright. As already stated it was unchanged. The result would have been the same had the X-light been composed of particles with positive charges. I have already, in the *American Journal of Science* for October, 1900, mentioned experiments adverse to the idea that X-light is a flight of uncharged particles. I also caused the condenser to revolve to see if there was any deflection of a beam of light passing through it. I observed none. Surely such a deflection should have appeared if the light had been composed of a flight of particles even though these started out with such a high velocity as has been erroneously given to such particles, for long before the stragglers got through the last of the 500 sheets they must have been only creeping along.

NOTE CXXXIV—ON PHOTOGRAPHIC RESULTS WITH X-LIGHT.

In these notes I have considered chiefly fluoroscopic results because they were of prime importance to my friend, Dr. F. H. Williams, as they must always be to the physician as distinguished from the surgeon. Not until apparatus comes into use powerful enough to take instantaneous photographs of the soft tissues in the thick parts of the body can photography prove as valuable to the physician as the fluoroscope and for many cases it will always be of less importance. For the surgeon who wants photographic records, especially in diseases of the bone, where details of structure are of such great value, photography is superior to eye observations. No fluoroscopic screen as yet gives the beautiful definition of a photograph obtained by the light of a tube in which the cathode stream particles strike the same spot on the target at uniform velocities in rythmic surges. It has been shown, in previous notes, that for the present most observers need to practice economy by storing the current in reservoirs connected with the secondary of the induction coil, and sending it in powerful surges through the tube so that each surge will give the right quality of light in the proper amount and the number of surges be reduced to the smallest which will permit the light to be continuous to the eye. But for photographic purposes the current must be used in another way. This has been demonstrated in a remarkable way by Mr. John O. Heinze, Jr., by means of his break and an A. W. L. coil of greater power than any X-light generator yet produced. The coil was arranged as I have directed for fluoroscopic work, and a tube with large terminals was used. The coil was furnished with reservoirs having large storage capacity in the secondary to give the surges of proper size. With this arrangement of the apparatus light of the correct quality for the fluoroscope was supplied in surprising volume, but the photographic results were not in proportion to the cost of the coil. After much experimenting Mr. Heinze used tubes with cathodes as small as those we employed for high-frequency coils, reduced the storage capacity of the secondary to fit the cathode, and sent the surges as fast as possible. A target capable of standing a large amount of heat was employed. Under these conditions it was possible to take a photograph of a hand with a practically instantaneous exposure. There are several reasons why this could be done. Some of these I have already spoken of in earlier notes, but will mention them here again. Others will be advanced by Mr. Heinze. First, in note vi, it was shown that in a vacuum tube we get X-light of many different wave-lengths, some so short that (as pointed out by Elihu Thomson) they do not affect any apparatus we have. But leaving out of account these shortest waves there are others which will not affect a photographic plate but will brightly illuminate a fluorescent screen. Second, in note xlv,—on harmonics—it was shown that to get the best results from the least power the surges should come in regular order. In the case of a fluorescent screen which makes the X-light visible by reducing its wave-lengths several octaves, the active salts are phosphorescent to a slight extent, the light yield in consequence being less dependent upon having the cathode surges regular and rapid. In considering photographic results we may liken the large aggregations of bromide of silver particles to a complex structure like a bridge, and the surges to a great number of soldiers. If the soldiers move irregularly the effect they produce on the bridge is slight, but if the movement is rythmic there comes a time when the bridge is in danger and this is what happens with the photographic film, only it is carried further, the bromide groups being toppled over by the harmonic surges faster than they would be by irregular ones.

NOTE CXXXV—THE SOURCES OF THE CATHODE STREAM.

It was shown in earlier notes that the cathode stream particles came from several sources, the terminals and the residual gases. The importance of allowing those from the residual gases and from the anode to reach the cathode was shown by means of tubes with movable terminals. Another unpublished experiment bearing on this matter is mentioned here. The cathode of an X-light tube was placed in a glass receptacle with an opening toward the target, which was only large enough to allow the stream to pass through it. When the gases from the cathode had been removed by heat and heavy surges the tube was of no practical use as a source of X-light, for the free circulation of the gases had been interfered with and the cathode stream had had no time to recuperate.

A further gift of $1,250,000 has been made to the University of Chicago by Mr. John D. Rockefeller, which brings the total amount given by him up to $10,251,000.

New Fuel for Swedish Railroads.

The following information about the fuel problem in Sweden is sent from Gothenburg by United States Consul Robert S. Bergh: Sweden imports yearly large quantities of coal and coke, and this trade is increasing steadily, in pace with the industrial activity and the building of new railroads. Several millions of dollars are annually paid out to foreign countries for fuel. This has caused the authorities to consider whether Sweden could be made more independent in this respect. It has been suggested that the state railroads could get their motive power partly from waterfalls, and experiments will probably be made in this line.

The managers of the state railroads have been instructed to make trials of peat, peat charcoal and peat briquettes as fuel for locomotives. The intention is to construct a special locomotive to be used in these experiments, and if it is successful other engines will undoubtedly be built, because peat is abundant in this country.

The navy and the state railroads have also tried to use Swedish coal, but without much success; the efforts will be continued, however. A Gothenburg newspaper reports as follows:

In the new briquette factory at Elmhult, belonging to the state, experiments will be made this fall in the production of a cheap and practical fuel for Swedish railroads. In locomotive furnaces, Swedish coal can not be used alone, because it contains too much scrap and incombustible substances, which are not consumed, but form offal and ashes. It must, therefore, be mixed with English coal, but this is becoming more and more expensive. The possibility of using Swedish coal alone is therefore ideal, and the above-mentioned factory has been built to be employed in the attempts to make or refine Swedish coal into a good fuel. The factory will operate according to a German patented method, and has been put up under the supervision of a German. It will be started this fall, and the work will continue night and day. It is calculated that the output will be thirty-six briquettes per minute—that is, 51,840 per twenty-four hours, or fifteen carloads of 10,000 kilogrammes per car. Experiments will first be made with forty carloads of Swedish coal of the lowest grade.

A New Relay.

The "Armorl" electrocapillary relay has recently been described as follows in the London *Electrician:* This relay, said to be sensitive to one-three-hundredth volt, is based on the same principle as the capillary electrometer—*viz.*, the action of an electric current on a liquid contained in a capillary tube. The apparatus consists of an inverted U-tube containing mercury. One end of this tube is immersed in a mercury reservoir, and the other end, which is drawn to a fine point, reducing the bore to something in the order of 0.004 inch, dips in a bath of dilute acid. Just beneath this point is one end of a lever whose middle rests on a knife edge, the other end of the lever moving between the two contacts of the local circuit. The height of the mercury in the reservoir is such that its pressure is just balanced by the capillary force at the point of the tube. The current is led in at the top of the bend of the U-tube and out at the bath of dilute acid. As soon as a small current passes, the capillary force is diminished, and the mercury begins to drop from the tube, ceasing again as soon as the current ceases. The mercury falling on the end of the lever tips it up and closes the local circuit. We were invited last week to inspect this relay, which, we are informed, is the joint invention of Messrs. Axel Orling and J. T. Armstrong, but we were shown no more than experiments and diagrams by way of explanation of its action. Not having seen the actual apparatus, we are unable to form any opinion of its merits. The utility and reliability of the apparatus must be largely dependent on the mechanical details of its construction.

American Goods for Australia.

United States Consul-General Bray has reported from Melbourne that one of the most valuable cargoes ever carried to Australia has arrived there from Brooklyn. It includes twenty-four locomotives, built by the Baldwin Locomotive Works, for the government of New South Wales, some 4,000 tons of miscellaneous manufactured goods shipped by various commission houses doing business with Australia, and about 700 tons of paper. The cargo amounts to nearly 10,000 tons, and is valued at over $1,000,000.

The experiments of the Swedish Navy in the development of wireless telegraphy have been so successful in the autumn manœuvres that the government has decided to make provision for the erection of an extensive system of coast signaling stations. It has been shown by the tests that it is possible to transmit orders from the Navy Department, in Stockholm, by means of the ordinary telegraph system to the specially erected coast stations, and from them, by wireless telegraphy, to warships among the islands off the coast at a distance of about thirty miles. It is said that the engineers have made several inventions which increased the efficiency of communication by wireless telegraphy.

Copper Mining Industry.

The Geological Survey will soon issue a report on the copper mining and smelting industry of the United States in 1900.

The industry, the report says, was exceedingly prosperous during the year. Values remained at a relatively high level, and while some of the great producers, through a variety of specific causes, did not contribute as much metal as in former years others largely increased their output. There was very great activity in the opening of old mines and the development of new properties, but only a few reached the productive stage in 1900. One by one, the report says, they will appear as sellers in the copper market in 1901 and 1902.

The report contains figures showing the great strides made in the mining of copper since its inception as an industry in the United States. In 1845 the total output of the entire country was only 100 tons, in 1850 it was 650 tons, in 1869 12,500 tons and in 1880, 27,000. Since 1880 Montana and Arizona have entered the field, and the yearly output has increased by leaps and bounds. In 1883 the output was 51,574 tons, in 1890, 115,966 tons, and in 1900 the gross tonnage of mined copper was 270,588 tons. In the comparatively early stage of the copper industry, that is, prior to 1880, when the new fields in Montana and Arizona began to make themselves important factors in the output of the United States, by far the greatest percentage of the total output came from the Lake Superior region. In 1849 the percentage of the Lake Superior product of the total output was 96; in 1850, 88; in 1869, 95.1, and in 1880, 82.2. With the discovery of the Montana and Arizona mines, however, the percentage of the total product of copper mines in the Lake Superior region began to decrease. It was 20.7 in 1883, 13.4 in 1890, and 19.5 in 1900.

The exports of copper from the United States have steadily increased during the last few years. In 1893, 80,392 tons of fine copper were exported; in 1896, 125,605 tons; in 1898, 145,115 tons, and in 1900, 160,082 tons. The heaviest exports took place in the first half of 1900, when 90,743 long tons were shipped. The product of Montana in 1900 broke all records, being 770,738,439 pounds, while in Arizona there was a slight falling off.

Mr. Andrew Carnegie, it is said, will endow liberally the Carnegie Laboratory of Engineering of the Stevens Institute when it is dedicated February 6.

The New York Electrical Society.

The 219th meeting of the New York Electrical Society was held on December 19. At this meeting Professor Dayton C. Miller, of the Case School of Applied Science, Cleveland, Ohio, delivered a very interesting lecture on "Polarized Light." In order to explain the nature of light when considered as a wave motion in the ether some very interesting models were employed. The various kinds of apparatus for producing polarized light were explained, together with many of the applications of this light. The action of the different plates and crystals for the production of polarized light was explained. A collection of unusually perfect specimens of crystals was exhibited. The following members were elected: Frank Scott, Ampere, N. J.; Hugh A. Brown, Rutherford, N. J.; Edward B. Brisky, New York city; Raymond Healy, Brooklyn, N. Y.; F. J. Youngblood, Hoboken, N. J.; Vernon E. Royle, Paterson, N. J.; Thaddeus R. Bell, New York city; W. Jac Marland, New York city; W. H. Brown, New York city; Richard Braithwaite, Jersey City, N. J.; Wm. E. Toldt, Newark, N. J.; M. F. McAlpin, New York city.

The St. Louis Exposition.

The breaking of ground for the Louisiana Purchase Exposition, in St. Louis, December 20, marks the beginning of a new era in that city's history. Already the good effects of the coming show are to be seen in the city. Business men generally apprehend an increase in all lines of business during the time intervening between this and the opening of the exposition, and this will not be confined to local trade alone. St. Louis is going to spend millions of dollars to place herself more conspicuously in the first rank of American cities, and to turn upon her, for a period of two years, the eyes of the civilized world. The exposition is going to be a giant. All that brains and energy and money can do to make it the greatest in the world's history will be done. Of course, one of the more prominent—if, indeed, it be not the most prominent—of all the departments will be that of electricity. Mr. Henry Rustin, who was in charge of the electrical features at Omaha and Buffalo, has already "opened shop" in St. Louis, and has a force of men actively at work on the preliminary arrangements. In conversation with Mr. Rustin a few days since he said that everything in the electrical department was working well. "All the talk we hear on the subject of exhibits is big talk," he said. The exhibitors generally seemed disposed to enter the exposition upon the same grand scale upon which the show is designed. The building for electrical exhibits will contain over three hundred thousand feet of floor space. It will be shaped like a keystone, and, aside from occupying one of the most important sites, will be a model of appropriate architectural beauty and splendor. I am told that the appropriations both for this building and for general lighting effects will be very liberal. In fact, no expense will be spared to make the electrical features of the show the most splendid and instructive of the century.

Election Traction in Nottingham.

United States Consul S. C. McFarland writes as follows from Nottingham, England: I reported the construction of one branch of a contemplated system of electric street railways to supersede the old horse-car lines previously in existence. At that time, about two miles of double track were in operation; since then some four and one-half miles have been added and put in operation, and track has been laid for several additional miles. The institution of this modern system, which has been established without regard to expense and is strictly first class in all of its appointments, gave a shock to the conservative element of the population, and prophecies were freely made that the scheme would prove a financial failure. That these prophecies were false is clearly shown in the first report of the tramways committee, which I summarize below, and it must follow that the system will be extended to take in several populous suburbs already clamoring for the improvement. In fact, parliamentary powers have already been applied for to widen the system beyond its orignal scope, and it will surely be extended later on. In moving the adoption of the tramways committee's report, the chairman compared the receipts of the electric system, so far as completed, with the revenues obtained from the old horse-car lines, and his figures are instructive. The Sherwood line, he said, from the opening of the system on January 1, had brought £15,396 ($74,924.62), against the horse cars for the past year £4,258 ($20,721.55), a difference of £11,138 ($54,203.07). They carried last year 616,000 passengers, and this year 3,063,000, an increase of 2,500,000. The Sherwood line was carrying an average of about half as many as the whole of the horse trams last year. The Bulwell electric cars were even more striking. In the five weeks the cars had been running £4,554 ($22,162.04) had been earned, as against £1,556 ($7,572.27) from the horse cars, an increase of £2,998 ($14,589.76). The passengers had increased from 247,000 to 815,000, in round figures. The line was carrying an average of 8,000,000 passengers per year; that alone was equal to the whole of the horse cars last year, while the cost per mile was not more.

A Mistake of Nature Revealed by the Telegraph.

A woman's Morse is as feminine as her voice or her handwriting. I have often put to the test my ability to distinguish between the Morse of a man and that of a woman, and only once have I been deceived.

On this same Washington "circuit" I one day encountered a sender at the other end, a stranger, who for hours "roasted" me as I seldom had been in my telegraphic experience. The dots and dashes poured from the sounder in a bewildering torrent, and I had the hardest kind of work to keep up in copying. With all its fearful swiftness the Morse was clean-clipped and musical, though it had a harsh, staccato ring which indicated a lack of sentiment and feeling in the transmitter. From this, and from a certain dash and swagger I gathered, before the day was out, a pretty distinct impression of the personality of the transmitter. I conceived him to be of a well-kept, aggressively clean appearance, with a shining red complexion and close-cropped hair; one, in brief, whose whole manner and make-up bespoke the self-satisfied sport. That he wore a diamond in his loudly striped shirt-front I considered extremely likely, and that he carried a toothpick between his lips was morally certain.

Next day I took occasion to make some enquiries of my fellow operator at Washington.

"Oh, you mean TY," he said, laughing. "Yes, for a girl, she is a fly sender."

It was mortifying to find that I had mistaken the sex of the sender, but I was consoled when I met the young woman. The high coloring was there, and the self-satisfied air; so also were the masculine ties, the man's vest and the striped shirt-front. Nor were the diamond pin and the toothpick wanting. When she introduced herself by her sign, called me "Cully," and said I was "a crack-a-jack receiver," I was convinced that it was nature, and not I, that had made the mistake as to her sex.—L. C. Hall, in *McClure's*.

News from Great Britain.

(From Our Special Correspondent.)

THE LONG expected tariff of subscriptions in connection with government telephone system in London has now been published, and altogether these do not appear to give the enormous advantages which were probably anticipated in some quarters. The National company's charge for unlimited service is £17 per annum, and the Post Office charge will be the same. But the latter caters more liberally for the small user of the telephone. The charges for connection with any exchange in the county of London within two miles of the subscriber's premises are £5, and one penny per call within London and twopence outside. For connection with outside exchanges, £4, and one penny per call on the same exchange and twopence on any other exchange. Party-line communication at £3 for two subscribers and £2 up to ten subscribers is also offered, with call fees the same as above. There are also additional annual charges under various circumstances, such, for instance, as when a subscriber's premises are more than two miles from the exchange, and so on. The most pleasing announcement made with the publication of the above tariff is the fact that Post Office subscribers will have the right to communicate with the National company's customers in the London area. This facility was only obtained after much negotiation between the two parties. Without it the Post Office could never have made its system work, as it is quite obvious that a firm would have been cut off communication with many of its business friends unless it subscribed to both systems, an unlikely course. But this possible difficulty has been overcome and should benefit both systems accordingly. A further concession on the part of the company is its decision to charge the same rates in London as the Post Office, a decision which would not point to any furious competition, after all. Even now, however, no date is mentioned when subscribers can be connected up.

The London County Council has been instrumental in invoking showers of congratulations and murmurs of disapproval all in a single week, the former by reason of its allocation of the contracts for its tramway equipment and the latter on account of its attitude in connection with proposed underground tramways in London. Dealing first of all with the tramway contracts it is satisfactory to see the order for the three-phase and continuous-current generating machinery go to an English firm—*viz.*, Messrs. Dick, Kerr & Company—out of twenty-nine firms which tendered. These dynamos, two continuous-current and two three-phase machines, all rated at 1,500 kilowatts, will be manufactured at Preston and will be driven by Ferranti engines. Among other tenders accepted previously to the above, however, is one by Messrs. J. G. White & Company, American, for the roadwork and plate-laying for a sum more than twice that of Messrs. Dick, Kerr & Company's tender.

With regard to the question of shallow tramways in London, it will be remembered that the council's electrical engineer recently visited America with a view to study similar lines in New York and elsewhere. The outcome of this visit was a recommendation at the last meeting that the council should apply next session first for powers to make subways in streets for the reception of pipes, wires and other things, where desirable, and for electric traction and other purposes of locomotion, and secondly for powers to construct such subways under certain streets. This motion was carried unanimously, but the idea has not been received at all favorably, particularly by the electrical press, which claims that the object of the council is to extinguish underground deep level electric railway enterprise. At any rate, the motion is passed and the council's bill will duly make an appearance before the Houses of Parliament.

For the first time in its history London is now possessed of a through rapid communication between its northern and southern suburbs, a boon conferred by the opening of the northern section of the City & South London Railway, a noteworthy example of underground electric railway construction at the hands of purely British capital and labor. The total length of the line is six and one-half miles and the time taken is about twenty minutes from end to end. Only a week or so back the chairman of the London County Council, in opening the Battersea electric light station, which is in the south, complained of the numerous changes from tram to bus and thence to tram in order to travel right across London, and a few more such lines as the one referred to would transform London into a London where one could contemplate travel without a sigh. The process of evolution was ever slow, but it is a joy to know that there is every indication of a little hurry in the near future.

The question of orders for electrical machinery being placed out of the country was rather vividly brought to mind during the visit of the Institution of Electrical Engineers to Germany in June last. It will probably be remembered that in 1899, owing to a lively agitation against the conditions of electric supply in the city under the City of London Electric Lighting Company, powers were granted to the Charing Cross & Strand Electric Supply Corporation to give a competitive supply. At first sight it was quite obvious that a site for a generating station could not possibly be found anywhere near the area of supply and that, therefore, a certain amount of high-pressure, long-distance transmission would be necessary. Therefore, a piece of land was taken some five or six miles out, and generation was decided upon at 10,000 volts. It was these very 1,600-kilowatt, 10,000-volt machines which the members of the institution had the pleasure (?) of seeing in various stages of completion in Messrs. Lahmeyer's works, at Frankfort-on-the-Main. The engineers to the London County Council, too, have given offence here, as in drawing up the specifications for the machinery to be installed in the Council's new tramway power-house which will be of the three-phase type, they stipulate that firms tendering must have made large three-phase dynamos which have been in successful use for at least twelve months. This is looked upon as being an unnecessary condition and one which practically prevents the orders being placed with home contractors.

Probably stimulated by the action of the London County Council, both the Wolverhampton and Bournemouth corporations are having short tracks of conduit tramway laid down. At Wolverhampton the Lorain Company (American) is putting an experimental line down on the condition that it removes it should no success attend its efforts, and that the local body purchases it in the event of its proving to its satisfaction. At Bournemouth, Messrs. E. J. G. White, also American, have the order for a length of similar track for the centre part of the town, which will be joined up to the trolley system on the outskirts.

London, December 7. A. W.

Fuse Plug Cabinet Panels.

In all modern buildings the electric systems require controlling panels at the various centres of distribution. Inasmuch as the type of cutout known as the Edison fuse plug has been perhaps more widely adopted than any other for use in the wiring of buildings, it has been a natural

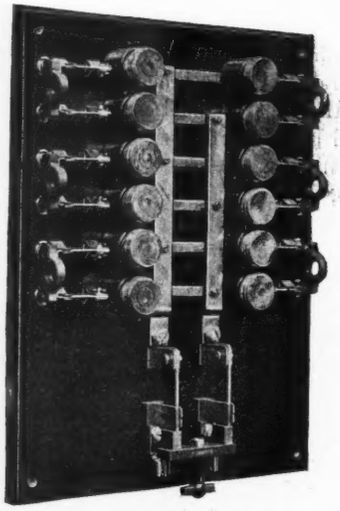


FIG. 1.—FUSE PLUG CABINET PANEL.

consequence that a line of cabinet panels should be brought out embodying the same idea in connection with the necessary switches constituting a panel controlling the circuits at any centre of distribution. Following this idea the General Electric Company has developed a line of panels providing for almost all installations.

FIG. 2.—FUSE PLUG.

The general designs of these are indicated by the illustrations. The entire line has been approved by the Board of Underwriters. As indicated above, the most important feature in connection with these panels is the use of the Edison fuse plug, which permits a compact arrangement of the greatest convenience. These plugs are easily connected by any one, without danger, and the operation, as is well known, does not necessitate the use of any tools whatever. Repeated tests show that these fuse plugs will safely interrupt short-circuits and confine the arc to the interior of the plug. These plugs are now made for 125 volts and for 250 volts, and either type can be furnished as required. The various metal parts are designed with ample cross-section for use with the largest plugs supplied by this company, the standard capacity for this work being, however, fifteen amperes. The metal parts are mounted on black enameled slate base, the whole being finished in a manner suitable for installation in buildings of the finest construction. The standard line of panels has the following arrangements of circuits:

Two-wire mains with right, left or double branches, two to twenty circuits; three-wire mains with two-wire right, left or double branches, two to twenty circuits; three-wire mains with three-wire double branches, two to twenty circuits.

The mains are brought to the bus-bars through cable terminals or knife-blade switches with cable terminals.

Automatic Self-Starting, Single-Phase Induction Motors.

For the very large number of small power uses to which it is convenient to apply motors operated upon single-phase alternating currents of the ordinary frequencies distributed for lighting, the Emerson Electric Manufacturing Company, of St. Louis, Mo., has designed the type of motor illustrated in the accompanying engravings, which presents many points of novelty and interest.

The motor is supplied with three terminal blocks, having two main terminals and one auxiliary. The accompanying diagram of winding and connection shows the arrangement of these and the circuits leading from them. The auxiliary coils, shown as the inner set in the diagram, are used only in starting the motor. The cutout switch is so arranged as to close the circuit at the moment of starting through the starting coil and induce currents out of phase to a sufficient degree to permit the armature to start. The armature is, of course, of the short-circuited type, of exceedingly simple and strong construction mechanically, and under no circumstances can it be burned out. The operation of the auxiliary circuit and cutout is automatic, a very simple but efficient automatic cutout switch being placed inside the motor and serving effectually to cut out the auxiliary starting coil after the motor has attained speed. These motors are made in two designs, one adapted for starting its full load and the other for starting light and having the load subsequently clutched on. They are made to produce actual brake power of from one-sixth to one-half horse-power, and are carried in stock for operation on standard 60 and 133-cycle current at 100 to 110 volts. They can be furnished for special voltages and frequencies to special order.

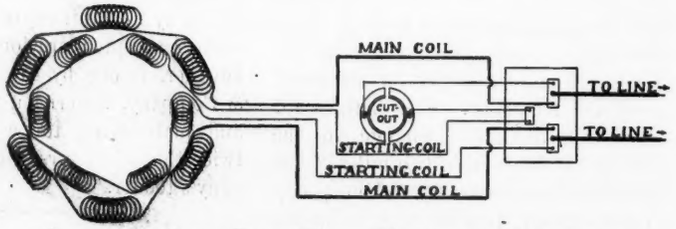


DIAGRAM OF SINGLE-PHASE MOTOR, WINDING AND CONNECTIONS.

Device for Protecting Firemen.

In San Francisco, Cal., it is reported that a grounding device for trolley wires to be used at fires will be put in use shortly. For this purpose a long pole, which carries within it a conducting wire provided with a switch—the pole having its end formed into contact pieces—is used. This pole is placed so as to connect the trolley wire with the track and the switch

A NEW ALTERNATING-CURRENT MOTOR.

then thrown, which short-circuits the line current and throws the automatic circuit-breaker in the station, entirely cutting out the corresponding section of line. This device is for the purpose of preventing shocks to firemen, which come from the stream of water coming in contact with a live wire. Mr. W. R. Hewitt, who is connected with the department of electricity in San Francisco, designed this device.

Electric Locomotives.

Some very interesting types of electric locomotives are illustrated in the following columns. These locomotives are manufactured by the C. W. Hunt Company, of West New Brighton, N. Y. The locomotive illustrated in Fig. 1 is designed for furnishing motive power in factories where heavy material is to be moved on narrow-gauge cars. It is adaptable for curves with a radius as small as twelve feet. It is carried on two swiveling eight-wheel trucks, with every wheel a driver, which enables it to ascend steep grades. With a machine adapted to such sharp curves almost any part of a factory may be reached.

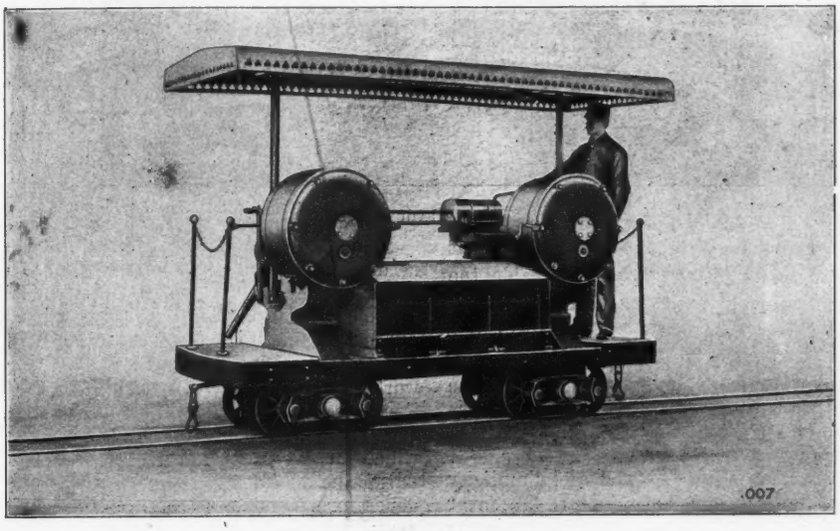


FIG. 1.—ELECTRIC LOCOMOTIVE.

If the locomotive is not at work no power is used or wasted. If it is at work, only the power needed to do the work is taken. One man handles the locomotive, and usually does the coupling and more or less of the yard work, and keeps the switches and tracks in order.

The energy for its daily work is furnished by a storage battery, which is recharged at night, or at intervals during the day when the locomotive is idle. In many situations the locomotive will have various intermissions in its work during the day that can be utilized for charging, and the batteries can be kept fully charged without charging at night. The daily recharging of the batteries requires about one-quarter as much time as the locomotive has been in active work during the day.

The battery on the locomotive is divided into sections, which are connected through the controller with the motor armatures and fields in various combinations of series-parallel connections, thus obtaining the different variations of draw-bar pull and speed required for general shop work. Unusually large and heavy battery plates are used, which are not overworked even in starting the load, thus ensuring durability and efficiency of the lead plates.

There are no rheostats or resistances of any kind, thus avoiding waste of electric energy either in starting or in running. The motors are proportioned to the normal output of the batteries, and to the weight of the locomotive so as to avoid overloading by the motorman.

Two independent electric motors are used, either in series or in multiple, which at low speeds are said to give a large starting effort with a minimum consumption of electric current—an object especially desirable with storage batteries, as they can be charged with only a limited amount of energy. It is evident that any increase in the efficiency of either the motors or the mechanism is equivalent to increasing the life of the batteries and the radius of action of the locomotive. These motors are said to possess the valuable quality of pulling the hardest when the load is being started and the speed is the slowest, and lessening the pull and increasing their speed as the car is accelerated.

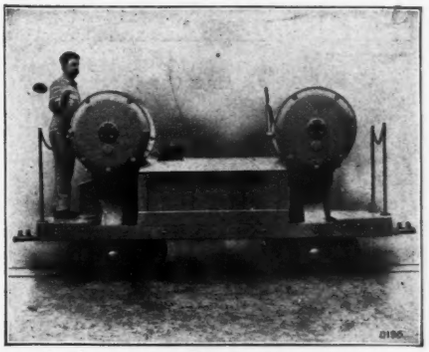


FIG. 2.—ELECTRIC LOCOMOTIVE WITHOUT COVER.

In Fig. 4 is shown a type of electric switching locomotive for use on standard gauge track. The power for these locomotives is furnished from storage batteries and they are manufactured with different capacities for the purpose of meeting the variety of service required in yard work. They are built in accordance with the Master Car Builders' standards, and two motors are used for driving them, which are so arranged as to make every wheel a driving-wheel. By using storage batteries they are made much heavier than they would be if trolleys were used, but in this case the weight is an advantage, as it enables them to pull much heavier loads. These locomotives are especially adapted to manufacturing establishments where there is great risk of fire.

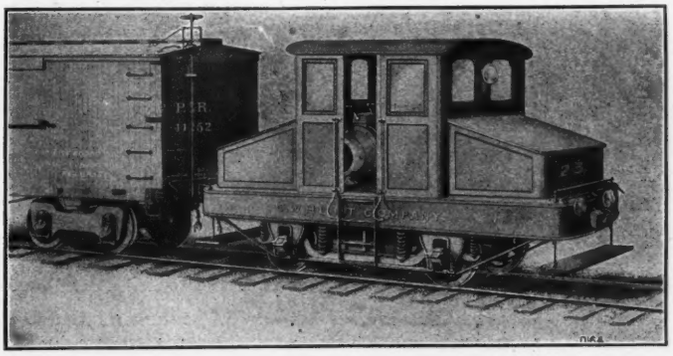


FIG. 4.—ELECTRIC SWITCHING LOCOMOTIVE.

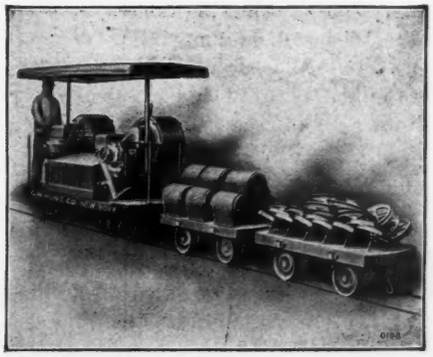


FIG. 3.—ELECTRIC LOCOMOTIVE IN OPERATION.

A New Cable Hanger.

In cities and densely populated sections of the country where overhead construction of some kind is still permitted, aerial cables are destined to be an important feature for a long time to come. They represent a great advance over the ordinary overhead construction, where from fifty to one hundred single iron or copper wires are attached to as many insulators on cross-arms. These wires, properly insulated, are grouped and lead-encased, or sometimes covered with rubber, jute or paper, thus forming a cable. A cable, which is from one to two inches in diameter, may contain wires for telephone, for telegraph or for light and power purposes.

A New Cable Clip.

A cable is heavy and is not considered self-supporting in good practice, so a mechanical device or clip is necessary to attach it at intervals to the supporting or messenger wire. A cable clip should fulfill many requirements. It should be readily attached to and detached from the supporting wire at will, and yet not

Cable Clip in Operation.

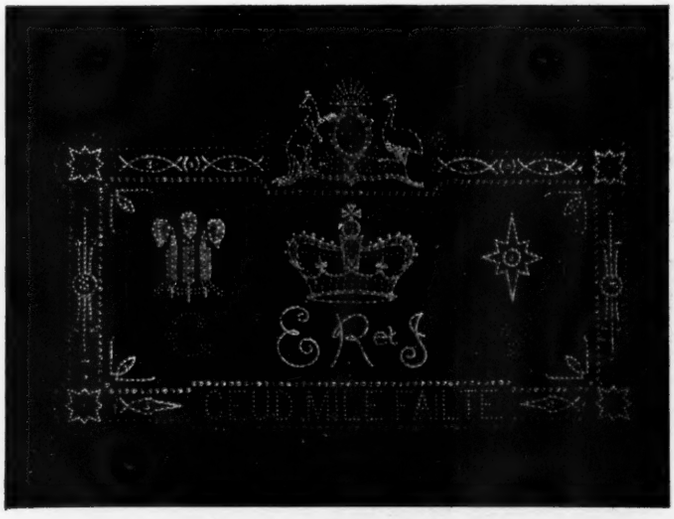
detachable from either by accident. It should be attached without the use of any tools. It should ensure an absolute grip on the cable, so that the clips will not bunch while drawing the cables to position. It should offer no injury to the cable. It should be durable and strong, to sustain any overload from ice and snow. It should be adjustable to any size cable used.

The new cable clip here illustrated is worthy of consideration, as it is claimed to embody in its design and construction all the above specifications. As shown in the illustration, it consists of a strip of zinc which is bent about a locust button, forming a loop at one end, and threaded through a formed galvanized wire, leaving a hook at the other end. This makes the clip practically all in one piece and easy to handle. It is readily attached by passing the hooked end through the looped end, thus enclosing the cable, and it is then quickly hooked to the messenger wire. It will be seen that a slight twist, or quarter turn, may be given to the hook for it to pass through the loop freely. This, however, is done very quickly while the clip is being hooked to the messenger wire. The clip forms a loop about the cable so that the greater the weight of the cable the greater the grip of the clip. The loop also makes it adjustable to any size cable. The zinc strip is soft and non-corrosive and prevents injury to the cable. The wooden button, like an insulator pin, is made of locust and is durable. The hook is galvanized steel wire.

Great strength, lightness and simplicity are claimed as strong points in favor of the New York cable clip, which is the trade name of this device. It is manufactured by Hurd & Company, of New York.

Illumination of the Town Hall and Treasury Building.

In all 11,000 lamps were used in the decorations, these being operated from two stations having a total generating capacity of 200 kilowatts. The entire work was carried out in thirty days, the machinery having been shipped from Sydney. The work was satisfactory and ran so well that it elicited the formal thanks of the government of Australia for the manner in which the contract was carried through. All of the apparatus used, comprising the generator plant, was of Westinghouse manufacture. The illumination was an interesting and highly successful example of the application of incandescent lamps to decorative purposes.



The Ducal Arms Emblazoned on the Front of the Parliamentary House.

Electrical Illumination at Adelaide, South Australia.

During the recent visit of the Duke and Duchess of Cornwall and York to Australia very elaborate decorations were exhibited in many of the cities. The city of Adelaide was the scene of a particularly fine electrical illumination, which was carried out in its various details by Messrs. Noyes Brothers, of Sydney. The accompanying illustrations show views of the Town Hall and Treasury Building and of the ducal arms emblazoned on the front of the Parliament House.

A Generous Offer.

Professor Alexander Graham Bell, of Washington, D. C., has offered his beautiful estate in Cape Breton, near Baddeck, as a temporary station for Mr. Marconi's wireless telegraphy experiments. Professor Bell has offered at the same time to furnish all the facilities which it is possible to do at the estate for the purpose of carrying on these experiments.

CURRENT ELECTRICAL NEWS

COMMERCIAL NEWS

DOMESTIC AND EXPORT

NEW WASHINGTON ELECTRIC PLANT—It is stated that work will be begun about March 1 on a large electric power plant at the mouth of Blue Creek, which is seven miles from the city of Walla Walla.

SOUTHERN RAILWAY TO USE ELECTRIC POWER—The machinery which is to be installed in the Southern Railway's new shops at Sheffield, Ala., is to be operated by electricity. The buildings will also be lighted by the same means. In these shops a modern equipment throughout is to be installed.

CARS TO BE LIGHTED BY ELECTRICITY—The Great Western Railway is carrying on negotiations with the Pullman Company to have its passenger cars lighted by electricity. The electric lighting system will be installed first upon some of the finest trains which run between Minneapolis and Chicago.

NEW YORK STATE RAILWAYS CONSOLIDATE—The Binghamton Railway Company and the Binghamton, Lestershire & Union Railway Company have consolidated under the name of the Binghamton Railway Company with a capital stock of $1,150,000, which represents the combined capital stock of the two former companies. The election of officers will soon be held.

OHIO ELECTRIC RAILWAYS CHANGE HANDS—The Parkersburg Interurban Lines have purchased the Marietta Electric Lines through Mr. C. R. Shattuck, of Parkersburg, representing the Parkersburg Interurban lines. It is reported that all these lines will eventually be merged into the Camden Interstate Electric System, which is constructing an electric road from Cincinnati to Pittsburgh.

A UNIQUE CHRISTMAS GIFT—The Schuylkill Traction Company gave ten per cent of the gross earnings of the road for the week beginning December 16 for a Christmas present for its employés. It is said that the gross earnings of the railway amount to about $3,000 per week, but that near the approach of Christmas they are much larger. It is probable that about $400 was distributed.

BILL TO PURCHASE TELEGRAPH LINES—A bill providing that the United States Government should purchase the Western Union and the Postal Telegraph companies has been introduced into Congress by Representative Jackson. It is planned to operate them in connection with the Post Office Department. By the provisions of the bill the properties are to be appraised and the amount reported to Congress.

OMAHA FRANCHISES TO BE SOLD—It is reported that the presidents of the companies having water, light and traction franchises have gone to New York for the purpose of negotiating for their sale to capitalists. The aggregate capital of these concerns is about $30,000,000. It is said that this deal has been planned for some time, but has been deferred by the high prices which some of the companies put on their properties.

NEW CUBAN TELEGRAPH COMPANY—The Cuban Telegraph and Telephone Company has been organized for the purpose of constructing and operating telephone and telegraph lines in Cuba and the West Indies. Papers of incorporation have been filed at Trenton, N. J. This company has a capital stock of $2,000,000. Messrs. Francis C. Prest, Edmund G. Vaughan and William J. Patterson are among the incorporators.

NEW CHICAGO UNDERGROUND TROLLEY COMPANY—The Chicago Underground Trolley Traction Company has been incorporated in South Dakota. This company is capitalized at $2,000,000. Among the incorporators is Mr. Daniel Bergin, who is the inventor of the Bergin underground trolley system. The object of the company is said to be to carry on a general electric transportation business wherever franchises may be secured.

CANADIAN ELECTRICAL STATISTICS—In the annual report of the Dominion statistician on the use of electricity in Canada is a number of interesting facts. There are 306 electric lighting companies as against 259 in 1898. The arc lights have increased in this time from 10,389 to 12,800, and the use of incandescent lamps from 463,615 to 815,676, all of which represents a large increase in the lighting facilities during this period.

FLORIDA RAILWAY NEWS—A $2,000,000 company has been organized for the purpose of constructing electric railways in Florida. Mr. John P. Martin, of Xenia, Ohio, is said to be at the head of this company. The object of the company is to build trolley lines from Tampa around the head of old Tampa Bay and down along the western coast until the city of St. Petersburg is reached. It is also planned to extend the system through Hillsboro County in many other directions.

INDEPENDENT TELEPHONE ACTIVITY IN INDIANA—A number of towns, including Logansport, Peoria and South Bend, are being equipped with modern telephone plants. A franchise has just been granted to a Fort Wayne company to install a system at Hammond. In some cases automatic switchboards will be used for decreasing the expense. The installation of telephone systems has gone on until there is a complete network of them extending over northern Indiana.

OHIO RAILWAYS CONSOLIDATE—The Mandelbaum-Pomeroy Syndicate has announced the consolidation of the following railways: The Southern Ohio Traction Company, Cincinnati & Northwestern Railway, Hamilton & Lindenwald Electric Railway and the Miamisburg & Germantown Electric Railway. It was announced to shareholders of the Southern Ohio Traction Company that the consideration of the usual dividend would be postponed until the consolidation of the four companies had been effected.

NEW CHICAGO TELEPHONE SERVICE—The Illinois Telegraph and Telephone Company has announced that it will adopt a new system of installing telephones. The subscriber will not be compelled to pay rental. The only necessity will be a deposit of $5, which is to cover the cost of the instrument. An automatic meter will charge five cents against him every time the telephone is used, and he will have to pay for the use of the telephone accordingly. This company is to use the automatic switchboard, doing away with the telephone operators.

ELECTRIC POWER FOR GUN TESTS—All the large guns at Sandy Hook, it is said, will soon undergo official tests when operated by electricity. The heavy ordinance is to be elevated and lowered by electric power and the ammunition will also be raised to the breeches by the same power. In this way it is planned to do away with many of the delays which now take place when the guns are operated by hand. The introduction of electric power, it is expected, will facilitate the work of testing large guns and save large sums to the government.

ELECTRIC LIGHTING

IRON MOUNTAIN, MICH.—The construction of a municipal electric light plant is being considered.

SHAMOKIN, PA.—The power plant of the Shamokin & Coal Township Electric Light Company has been completed and the lights have been turned on.

HUNTSVILLE, ALA.—The committee on lights of the city council has been directed to investigate the feasibility of establishing a municipal electric light plant.

FREDERICK, MD.—Land for a new electric lighting plant has been purchased by the city authorities. It is said that the object of this purchase is to remove the city electric light plant from its present location to the land bought.

BOYNE CITY, MICH.—W. H. White & Company have been granted a franchise for thirty years for street and commercial electric lighting. This company has also received the contract from the city council for lighting the streets.

SELLERSVILLE, PA.—Mr. Allen T. Dickson and others have been granted the privilege to string lines through the streets in Sellersville for the purpose of furnishing electric light and power. This ordinance was granted for a term of twenty-five years.

MCKEESPORT, PA.—The contract for lighting the streets of the city for a period of three years has been awarded to the Monongahela Light and Power Company at a rate of $70 per lamp. The contract in the aggregate amounts to about $22,000 a year.

JACKSON, MICH.—The Michigan Central Railway has awarded the contracts for the erection of additions to its shops near Jackson, Mich., to George B. Swift & Company, of Chicago. Among these improvements an electric power-house to furnish heat, light and power to the factories is included.

SOUTH BETHLEHEM, PA.—Mr. William H. Jacobs has been granted permission to erect poles and string wires on certain of the streets of South Bethlehem for the purpose of supplying electric light and power for commercial purposes. Several conditional clauses are attached to the ordinance granting the permission.

HOUSTON, TEX.—Stockholders of the Houston Light and Power Company have held a meeting and elected directors. Messrs. Blake Dupree and W. H. Chapman were among those elected. This company has a capital stock of $750,000. It has been organized for the purpose of furnishing light, heat and motive power to the city of Houston.

MOLINE, ILL.—A new power plant at an expense of about $100,000 is to be installed by Deere & Company. From this plant electric power is to be furnished to each department. Electric motors are to be installed so that each department may have power independent of the other departments. The system used will be practically the same as the one at the plant of the Deere & Mansur Company.

BIRMINGHAM, ALA.—The Birmingham Railway, Light and Power Company has purchased the Bessemer Electrical Company for about $25,000. It is said that the Birmingham Railway, Light and Power Company will establish an electric light and power station at Bessemer, which is similar to the one in Birmingham. The construction of such a station would mean an outlay of from $250,000 to $300,000.

TELEPHONE AND TELEGRAPH

PARKERSBURG, W. VA.—The new exchange building which the Bell Telephone Company is erecting will be ready for business about February 1.

JERSEYVILLE, ILL.—A franchise for ninety-nine years has been granted to the Calhoun County Telephone Company. The lines of this company will be connected with St. Louis.

EL PASO, TEX.—An independent telephone system has been installed by Mrs. Brett, who comes from Kansas City, Mo. Mrs. Brett organized the company and had the system installed.

SANTA ROSA, CAL.—The Sunset Telephone Company is preparing to rewire the city for its telephone service within a short time. Improvements throughout the service are to be made by the company.

PORTLAND, IND.—A franchise has been granted to the Redkey Telephone Company to extend its lines. This company was incorporated to operate in Jay, Wells, Blackford, Delaware and Randolph counties.

KENTON, OHIO—The Kenton Construction Company has been organized with a capital stock of $50,000. The object of the company is to build telephone exchanges. The first work undertaken will be that at Orange, Tex.

BRAZIL, IND.—Arrangements for installing a telephone system have been decided upon at the meeting of the stockholders of the Citizens' Telephone Company. It was decided to expend between $30,000 and $40,000.

IRONTON, OHIO—The directors of the Lawrence Telephone Company have met. It has been decided to increase the capital stock from $24,000 to $50,000 for the purpose of developing the company's property, which has been made necessary by the increase of business.

MCMINNVILLE, TENN.—The Citizens' Telephone Company has been organized and elected its officers. Mr. Jessie Walling has been elected president and Mr. W. S. Lively general manager. This company is to be a competitor of the Cumberland Telephone Company.

MCCOMB CITY, MISS.—A number of gentlemen have purchased the stock of the Pike County Telephone Company. Among these gentlemen are Messrs. J. J. White and Dr. O. B. Quin. Dr. Quin has been elected to the presidency of the company. The lines are to be extended and the service improved generally.

DULUTH, MINN.—The work on the new line of the Consolidated Telephone and Telegraph Company, between Duluth and St. Paul, has been completed as far as Moose Lake. Two bodies of men are at work in constructing the line, one at Miller and another near Harris. About forty miles of line still remain to be constructed.

WAUNAKEE, WIS.—Two telephone companies are building systems, in Waunakee. The Dane County Telephone Company has a force of men engaged in setting poles under its franchise and a franchise has been granted to the Farmers' Independent Telephone Company which is building an exchange and also a line to Middleton.

BALTIMORE, MD.—At a meeting of the directors of the Chesapeake & Potomac Telephone Company last week Hon. Bernard Carter, of Baltimore, and Mr. U. N. Bethell, of New York, were elected directors. There was no other change in the board of directors. Mr. Bethell was elected president of the company, succeeding Judge Jere Wilson, deceased. Mr. Bethell will also act as general manager of the company and will continue as general manager of the New York Telephone Company, of New York city.

ELECTRIC RAILWAYS

LORAIN, OHIO—The electric line between Lorain and Sandusky has been completed. This line is a connecting link between Cleveland and Detroit.

HARTFORD, CT.—It is expected that through cars from Springfield to Hartford will soon be running by way of Warehouse Point and East Windsor Hill, the line having now been nearly completed.

NYACK, N. Y.—The Rockland County Traction Company has anounced that its railway will be built and running by the first of May. It has not yet been announced just when the work of construction will commence.

GLOUCESTER CITY, PA.—The right of way for a trolley road between Gloucester City and Mt. Ephraim has been secured by men who are said to represent the South Jersey Gas Electric Traction Company.

ROCHESTER, N. Y.—The Rochester-Sodus Bay Railway Company has been authorized to increase its capital stock from $1,000,000 to $1,750,000. It is said that this increase will be used for construction purposes.

COOPERSBURG PA.—The Coopersburg trolley line has been nearly completed and cars to Allentown will soon be running. This railway has been constructed with ninety-five-pound rails and is stone ballasted.

ROCKFORD, ILL.—Mr. H. H. Clough represents parties who are applicants for a franchise for an electric line through Marengo. It is said that this movement signifies the connection of the Rockford system with that of Chicago and Fox River Valley.

IOWA CITY, IOWA—The construction of an electric line between Iowa City and points to the south and west is being agitated. The board of supervisors is to be asked to construct the bridge across the Iowa River so that it may be used by street railways.

MONTICELLO, N. Y.—The contract for constructing the Monticello, Fallsburgh & White Lake Trolley has been let by that company to Macatee & Company, of Philadelphia. Part of the road between Monticello and Fallsburgh is to be completed by July 1, 1902.

DOYLESTOWN, PA.—Estimates for an extension of the power-house of the Doylestown Electric Company have been invited from sub-contractors by William Steele & Sons. The power-house is to be a one-story brick building forty by forty feet.

FREMONT, OHIO—A large number of cars is being rebuilt at the Fremont shops of the electric railway to provide for the through traffic between Cleveland and Toledo. These cars are being equipped to provide the comforts which are ordinarily found on steam trains.

NEWCASTLE, PA.—Those who are interested in the construction of the Newcastle & Sharon Electric Railway Company have stated that nearly all the rights of way between Newcastle and Sharon have been secured and that the work of construction will soon be started.

LANCASTER, PA.—The city council has granted the privilege to the Lancaster City Street Railway Company to extend its tracks and to the Lancaster & Strasburg, the Lancaster & Manheim and the Lancaster & Mount Joy railway companies to run over the tracks of the city lines.

MAUCH CHUNK, PA.—The railway extension of the Mauch Chunk, Lehighton & Slatington Street Railway to Lehighton has been completed excepting the bridge over Beaver Creek. As soon as this bridge is completed trolley communication between Lehighton and Mauch Chunk will be established.

LOUISVILLE, KY.—Mr. Peyton N. Clarke is interested in the building of an electric railway to connect Louisville with Mt. Washington, Fairfield, Bloomfield and Bardstown. It is reported that northern capitalists are to be interested if possible. It is planned to build a road about forty miles in length.

ROME, N. Y.—The building of a rapid transit line between Lindale and Rome is being considered by the officials of the City Electric Railway Company. It is expected that Mr. Cunningham, of Washington, D. C., will soon meet the stockholders for the purpose of deciding whether the building of such a line is advisable.

INDIANAPOLIS, IND.—The Union Traction Company, it is said, will straighten its lines in order to reduce the running time of its cars between Indianapolis and Muncie. The running time of the fastest cars between Indianapolis and Muncie is one hour and fifty minutes, and it is intended to reduce this time twenty minutes.

WESTMINSTER, MD.—Those interested in the Washington, Westminster & Gettysburg Electric Railway Company have filed a mortgage to the Union Trust Company, of Philadelphia, to secure an issue of $1,850,000 in five per cent gold bonds. This is said to be a preliminary step in the construction of an electric railway from Gettysburg to Washington.

CHATTANOOGA, TENN.—It is stated that negotiations have been practically completed whereby the Rapid Transit Company will purchase the Chattanooga City Electric Railway Company's lines. The sale of the Chattanooga Light and Power Company will also be included. The United Light and Power Company controls the Rapid Transit Company.

ELIZABETH, N. J.—The directors of the Elizabeth, Plainfield & Central Street Railway Company have met and elected officers. Mr. Thomas C. Barr was elected president and Mr. John N. Ackerman, general manager. Mr. Barr is to have a general oversight of the railway and Mr. Ackerman will pay special attention to the line between Elizabeth and Plainfield.

NEW PHILADELPHIA, OHIO—The New Philadelphia & Uhrichsville Street Railway Company and the Canal Dover & New Philadelphia Street Car Company have been consolidated and passed into the hands of the Pomeroy-Mandelbaum Syndicate. An important link in the proposed Cleveland-Wheeling trolley road is formed by the consolidation of these two companies.

SPRINGFIELD, OHIO—An issue of $50,000 in bonds has been authorized by the directors and stockholders of the Springfield & Xenia Traction Company. The money is to pay for the completion of the construction of the railway. This company was formerly known as the Little Miami Traction Company, and it is said that it is now controlled by the Mandelbaum-Pomeroy Syndicate.

JEFFERSONVILLE, IND.—It has been announced that the building of an electric line to connect Indianapolis, New Albany and Jeffersonville will be begun March first, by a large force of men. It is the plan to connect at Seymour with a line which runs from Indianapolis to Franklin. Mr. Louis Schneck, of Seymour, is the president of the Jeffersonville, New Albany & Sellersville Rapid Transit Railway, which was organized a short time ago for building this line.

HERKIMER, N. Y.—A certificate of merger has been filed with the Secretary of State by the following railways: Herkimer, Mohawk, Ilion & Frankfort Street Railway Company, the Suburban Railway Company, the Deerfield & Utica Railway Company, the Little Falls & Herkimer Street Railway Company, and the Frankfort & Utica Street Railway Company. These companies are all to be consolidated into one company to be known as the Utica & Mohawk Valley Railroad.

ELECTRICAL SECURITIES

The fundamental conditions of the stock market continue good and the country's trade is very large and active. The most severe ordeal of late has been the collapse in Amalgamated Copper. The week closed, however, with the markets fairly strong and a general tendency toward advancement of prices. Local traction stocks were in demand and the leading electrical stocks held their own. At one time during the week there was considerable uneasiness respecting the money market. This seemed to have subsided, however, by Saturday.

The bank statement was a very excellent one as it was expected that it would show considerable falling off in surplus. It presented instead a gain of about $300,000. The surplus on December 21 amounted to $5,785,325.

ELECTRICAL SECURITIES FOR WEEK ENDING DECEMBER 21.

New York:	Closing.
Brooklyn R. T.	64¾
Con. Gas	215¾
Gen. Elec	281
Man. El	134
Met. St. Ry	163⅜
Kings Co. Elec	188
N. Y. & N. J. Tel. Co	166
Telep., Tel. & Cbl. Co	6½

There was an advance in price of Western Union said to be due to a report of the consolidation of the Western Union Telegraph Company and the Postal Telegraph Company. Prominent financial interests are said to be in favor of this consolidation, and also it is believed that the administration at Washington is in favor of a bill for the government ownership of the two systems.

The *Wall Street Journal* states that Brooklyn Rapid Transit was bought during the week on advices from interests more or less closely connected with the property that the chances favored a moderate advance. The point was given that net earnings would show better during the winter months as less improvement work would be done, this kind of work being mainly responsible for the increased operating expense in the last month or two.

Boston, December 21:	Closing.
Am. Telep. & Tel	163½
Erie Tel	17
New Eng. Tel	133
Mass. Elec. pf	94
Westing. Mfg. pf	73½
Edison Elec. (rights)	3½

The directors of the American Telegraph and Telephone Company have declared the regular quarterly dividend of 1½ per cent and an extra dividend of ¾ per cent, payable January 14 to stock on record December 31.

Westinghouse Electric and Manufacturing Company's directors have declared the regular quarterly dividend of 1¾ per cent on the preferred stock, payable January 2 to stockholders of record December 21, 1901.

Philadelphia, December 21:	Closing.
Elec. Co. of America	6¼
Philadelphia Elec	4⅞
Union Traction	32⅞
United G. I. Co	116½
Elec. Stor. Bat. c	60
Elec. Stor. Bat. pf	60

The directors of the Electric Storage Battery Company have declared the usual quarterly dividends of 1¼ per cent on both the common and preferred stocks, payable January 2 to stockholders of record December 24.

Chicago, December 21:	Closing.
Central Union Tel	40
Chicago Edison Light	158
Chicago Telep	240
Metropolitan El	90½
National Carbon	19½
National Carbon pf	83
Union Traction	10½
Union Traction pf	47

Union Traction has been fined $50 for refusing to issue transfers from West to North Side lines. The decision is important as bearing on the company's earnings.

It is reported that Lake Street Elevated will be reorganized. It will take up the debenture bonds and issue 4 per cent bonds instead. It will own an electric plant and cease getting current from Union Traction.

PERSONAL MENTION

MR. LEMUEL BANNISTER, who for the last five years has been the general manager of the British Westinghouse Company, has resigned.

MR. N. C. HAMILTON, of Hamilton & Son, Wheeling, W. Va., has been in New Martinsville, W. Va., subletting the contracts for the erection of the new electric light plant. The entire work is to be completed by the first of February.

MR. CHARLES M. MORSE, of Buffalo, N. Y., has been appointed deputy engineer commissioner of that city. Mr. Morse is a well-known civil and mechanical engineer and is manager of the Buffalo Engineering Company. The appointment is a highly commendable one.

MR. W. E. WINNER has asked the commissioners of Leavenworth County, Kan., for a franchise to build an electric railroad from Lansing to Lawrence. This line is to connect with the Kansas City-Leavenworth Electric Line at Lansing, and the line which is to be built from Kansas City to Topeka south to Tonganoxie.

MR. JOHN I. SABIN, president of the Chicago and Central Union Telephone companies, it is stated in a despatch from Chicago, will accept the presidency of the Erie Telegraph and Telephone Company, which is to be operated from Chicago. This, of course, will mean that the American Telephone and Telegraph Company has secured control of the company. This would place under the exclusive management of the Bell interests the five subsidiary companies of the Erie and prevent a disintegration of the Bell organization in controlling for its purposes all the territory of the United States.

AUTOMOBILE NOTES

A NEW AUTOMOBILE COMPANY — The Niagara Motor Vehicle Company has filed papers of incorporation in New York state for the purpose of manufacturing motors, dynamos and electric vehicles. Among the directors of the company are Messrs. Robert S. Weed and Charles A. Lindstrom, of Buffalo. Mr. Lindstrom was formerly connected with the Hewitt-Lindstrom Motor Company, of Chicago.

THE AUTOMOBILE CLUB OF AMERICA—The standing committees of the Automobile Club of America have been announced for 1902. The following gentlemen are the chairmen of the various committees: Dr. Schuyler S. Wheeler, the technical committee; Mr. Jefferson Seligman, the committee on runs and tours; Mr. J. M. Hall, the house committee; Mr. Albert R. Shattuck, the library committee; General George M. Smith, the membership committee; Mr. George F. Chamberlin, the committee on laws and ordinances; Mr. A. Ward Chamberlin, the sign post committee; Mr. Albert R. Shattuck, the good roads committee; Mr. J. Dunbar Wright, the committee on foreign relations; Mr. Albert C. Bostwick, the racing committee, and Mr. George W. Young, the auditing committee.

LEGAL NOTES

RESPONSIBILITY OF A COMPANY—A corporation, such as a street railway company, buying the property and franchise of another, not intending consolidation, is held in Capital Traction Company *vs.* Offutt (D. C. App.) 53 L. R. A. 390, not to be responsible for the older company's liabilities.

LIABILITY OF A RAILWAY COMPANY—An employé of a passenger railway company, who accepts transportation from the company as a mere gratuity, and not in consideration for his services, is held in Peterson *vs.* Seattle Traction Company (Wash.) 53 L. R. A. 586, to stand like any one else traveling on a free pass conditioned that the user shall assume risk of injury, notwithstanding the transportation would probably not be bestowed in the absence of the employment.

RIGHTS OF COMPANY SUPPLYING MATERIALS TO A CONTRACTOR—One who has furnished to a contractor materials which have not been paid for is held in Electric Appliance Company *vs.* United States Fidelity and Guaranty Company (Wis.) 53 L. R. A. 609, to have no right of action on a contract and bond in favor of a municipal corporation conditioned to erect a plant for it and turn it over free and clear of all claims for materials, where there is neither an attempt to secure his claim nor any contract legally enforceable in his favor.

STORAGE BATTERIES—An opinion has been filed by Judge Coxe, of the United States Circuit Court, in the case of the Electric Storage Battery Company against the National Battery Company, the American Bicycle Company and Eugene W. Belknap. By his opinion the validity of the Electric Storage Battery Company's Brush patent is sustained, and the National Battery Company is enjoined from the further manufacture and sale of storage batteries and from the further manufacture and sale of the Waverly electric vehicles equipped with infringing batteries. Mr. Belknap is enjoined from the further use of the Waverly electric vehicle.

MISCELLANEOUS

ENGLISH RAILWAY CONSIDERING CHANGE OF MOTIVE POWER—The London & Northwestern Railway is said to be considering the question of electrifying its entire system. It is stated that the directors and experts who were consulted in the matter are of the opinion that the road could greatly improve and cheapen its service.

NEW CAR COMPANY WORKS—Articles of incorporation have been filed by the American Palace Car Company at Albany, N. Y. This company is capitalized at $5,000,000, of which $4,000,000 is common stock and $1,000,000 preferred stock. This company has been formed for the purpose of building and leasing railway cars and coaches, passenger, freight and street cars and other rolling stock. Messrs. Joseph H. Hoadley and William J. Arkell, of New York, are among the directors.

LARGE NEW JERSEY POWER PLANT—The work of constructing the power plant at Columbia, N. J., is being pushed along rapidly by the Consolidated Power and Ice Company. A large dam has been built near the Delaware River for the purpose of generating electricity from water power. Turbines are to be installed together with the necessary electric power in the power-house which is now being built. The power to be supplied will be used by the electric railways in Pennsylvania and those which are soon to be built near it in New Jersey.

INDUSTRIAL ITEMS

THE LORAIN STEEL COMPANY, Motor Department, Lorain, Ohio, closed a contract with the Union Traction Company, of Philadelphia, for fifty four-motor motor equipments including controllers.

THE KELLOGG SWITCHBOARD AND SUPPLY COMPANY, of Chicago, has prepared a folder containing a special introductory offer for those who wish to install its telephone apparatus. This offer holds good until February 1, 1902.

THE JEWELL ELECTRICAL INSTRUMENT COMPANY, Chicago, Ill., manufactures electrical measuring instruments for use with direct-current apparatus. A fine line of illuminated dial switchboard instruments has been prepared by this company.

THE HART MANUFACTURING COMPANY, Hartford, Ct., manufactures the Hartford rosettes for cleat, concealed and moulding work. These rosettes have been approved by the National Board of Fire Underwriters and possess many points of excellence.

THE C. W. HUNT COMPANY, West New Brighton, N. Y., is sending out a very interesting table prepared for convenient insertion in memorandum books, giving electrical expressions and their equivalents. These slips will undoubtedly be in popular demand.

THE CHARLES WARNER COMPANY, of Wilmington, Del., has prepared an interesting cement and lime notebook for the year 1902. In this notebook are set forth the merits of Nazareth Portland cement and Cedar Hollow limoid. Descriptions of the other lines of trade in which this company is engaged are also given. The company will be pleased to mail a copy of this book to any one upon application.

THE AMERICAN STREET RAILWAY ASSOCIATION has issued its report upon the twentieth annual meeting which was held at Madison Square Garden, New York city, in October. This report contains many features of interest to street railway men. In it are included lists of the members of the association, papers read at the meeting and the discussions. The names of the exhibitors are also given.

THE ELECTRIC APPLIANCE COMPANY, Chicago, has prepared a blank which contains questions to be filled out. The answers to these questions give the company data regarding the condition of the plant as regards its requirements for lighting and enable it to furnish the lights which are best suited to the conditions. It would seem that such a blank would be of great use to many who have such plants in charge.

THE OSBURN FLEXIBLE CONDUIT COMPANY, 21 Park Row, New York, reports its factory running night and day turning out the new and flexible conduit "Flexduct." This conduit has been approved by the Boards of Fire Underwriters. It is thoroughly flexible and can readily be bent around posts, angles of floors, etc., and possesses many other points of excellence. The company is issuing a booklet on "Flexduct," which will be sent on application.

THE BRISTOL COMPANY, Waterbury, Ct., has prepared a circular in which is described its standard recording thermometers. These thermometers are designed for use in mash tubs, tanks containing liquid and closed spaces which are under pressure or vacuum. These thermometers are very useful in places which are very difficult of access and where it is desirable and often necessary to have the temperatures recorded. Copies of this circular will be sent upon application.

THE AMERICAN SCHOOL OF CORRESPONDENCE, Boston, Mass., is able to offer each year a limited number of free scholarships in its engineering courses to deserving and intelligent young men. The scholarships for 1902 are now at the disposal of the trustees and applications for them will now be considered. The courses of study offered by this school include nearly all branches of engineering and these scholarships should be of great value to deserving young men of limited means.

THE WESTERN ELECTRICAL SUPPLY COMPANY, of St. Louis, is sending out a neat circular which should prove valuable to contractors and construction men. This circular illustrates a new unit type of combined switch and enclosed fuse carrier. By carrying a small stock of these fuse carriers, panel boards can be built on short notice. This would seem to be very useful to contractors in saving the delay of having to order boards from the manufacturer.

MR. A. E. COLGATE, 56 Pine street, New York, is manufacturing a wiring computer which should be of great use in electrical work. It is designed for the busy man who is engaged in wiring and will tell him very conveniently three important facts which he must know; viz., the size wire he should use for a given loss of volts, current and distance, the several carrying capacities of wires, and the equivalent carrying capacities of wires. This instrument should find a wide use among men engaged in any kind of wiring for electric currents.

THE GENERAL ELECTRIC COMPANY has issued a very neat catalogue describing its Edison incandescent lamps for isolated plants. The main lamp sales offices are located at Harrison, N. J. In this catalogue only incandescent lamps for isolated plants for voltages of 90 to 125 and 200 to 250 are included. A catalogue describing all classes of incandescent lamps has also been issued by this company. This catalogue gives many points of interest about lamps for use in isolated plants and should be of use to men who have charge of such installations.

THE CENTRAL ELECTRIC COMPANY, of Chicago, Ill., has issued a price list especially adapted for those who wish to secure telephones and telephone supplies as quickly as possible. A large amount of data regarding these supplies is contained in this catalogue, which will be sent to any one upon application. The company desires to call attention to the D & W telephone protector which embodies a lightning arrester, line fuses and sneak coils upon which a descriptive bulletin has been prepared that will be mailed to anyone who is interested in this material.

THE PARAGON FAN AND MOTOR COMPANY, of New York, has issued bulletin No. 64, in which its multipolar motors and generators are described. In this bulletin are given the efficiency curves for these machines and very neat pictures of the different parts. The same company has also prepared bulletin No. 61 of its bipolar power motors and generators. The curves for the efficiencies of these machines are also given together with illustrations of the different parts. These bulletins should be very useful to those who have need to purchase such apparatus.

THE KEYSTONE ELECTRICAL INSTRUMENT COMPANY, Philadelphia, Pa., is at present putting on the market a fine line of electrical measuring instruments. It has designed a switchboard instrument which has the same system as the one employed in its illuminated dial instruments, but differs only in length of scale and style of case. The company especially recommends this instrument for use in isolated plants and on feeder circuits in electric lighting or street railway installations. A new catalogue of these instruments will be sent by this company upon application.

NEW INCORPORATIONS

BELLEFONTAINE, OHIO—Miller Storage Battery and Electric Company. $20,000.

MAXTON, N. C.—Carolina Electric Company. $50,000. To furnish light, power and heat.

IRONTON, OHIO—The Lawrence Telephone Company. Increased its capital stock from $24,000 to $50,000.

SEGUIN, TEX.—Seguin Milling and Power Company. $50,000. Incorporators: J. T. Holmes, Walter Nolte and others.

KENNETT SQUARE, PA.—Electric Specialty Company. $25,000. Stockholders: Dr. A. W. Gregg, James M. Worrall and others.

NACOGDOCHES, TEX.—Texas Central Telephone Company. $10,000. Incorporators: E. C. Branch, W. S. Beeson and W. S. Patton.

WINTERS, RUNNELS COUNTY, TEX.—The Winters Waterworks Company. $10,000. Incorporators: F. L. Pierce, J. W. Murray and others.

DULUTH, MINN.—The Black River Falls Company of Minnesota. $50,000. To manufacture electric power for lighting and manufacturing in St. Louis County.

MATTOON, ILL.—Farmers' Mutual Telephone Company. $10,000. To operate a telephone system. Incorporators: J. F. Miller, J. F. Brewster and A. G. Hildreth.

JERSEY CITY, N. J.—Power Equipment Company. $6,500,000. To manufacture motors, etc. Incorporators: Charles H. Johnson, John D. Elwell and John R. Simmons.

HOUSTON, TEX.—Houston Lighting and Power Company. $750,000. Directors: Blake Dupree, W. H. Chapman, of Houston; Howard C. Lewis, E. L. Carr and others of Schenectady, N. Y.

NEW YORK, N. Y.—The Grinnell Electric Cable Construction and Apparatus Company. $250,000. Directors: Henry B. Grinnell, Oscar A. Doering and Frank E. Thompson, all of New York city.

CAMDEN, N. J.—United States Light Manufacturing Company. $1,000,000. To manufacture light, etc. Principal office, 320 Market street. Incorporators: Paul Morris, C. Townsend Blake and others.

JERSEY CITY, N. J.—United Gas and Electric Company. $4,000,000. To manufacture gas, etc. The principal office of this company will be the Corporation Trust Company, 15 Exchange Place, Jersey City. Incorporators: Edward P. Meeker, Frank B. Pierce and others.

BUFFALO, N. Y.—Niagara Motor Vehicle Company. To manufacture motors, dynamos and electric vehicles. $25,000, divided into 250 shares. Its term of corporate existence is ninety-nine years. The directors for the first year are: Robert S. Weed, H. I. Slater and Charles A. Lindstrom, of Buffalo, and others.

INDIANAPOLIS, IND.—Greensburg, Shelbyville & Batesville Traction Company. $10,000. To build a line between Shelbyville and Greensburg, giving the Indianapolis interurban line connection with Greensburg, as a road is now being constructed from Indianapolis to Shelbyville. Directors: Louis Zoller, Sherman P. Minear, Charles R. Porter and others.

ALBANY, N. Y.—The Lake Shore Traction Company. $28,000. To construct a trolley road twenty-eight miles long connecting Westfield and Silver Creek, Chautauqua County. The directors are Arthur C. Wade, William R. Reynolds and others of Jamestown, N. Y.; Arthur B. Ottaway, of Westfield; Fred R. Green and Harry D. Kirkover, Jr., of Fredonia.

List of Electrical Patents Issued Last Week

[Specially reported for this journal by E. S. Duvall, solicitor of patents, Loan and Trust Building, Washington, D. C. Copies of any patent may be secured for 10 cents each.]

ISSUED DECEMBER 17, 1901.

688,813 Composition of matter as a non-conductor of electricity; J. M. Ancira, New York, N. Y.

688,817 Brush-holder; W. E. Baker, New York, N. Y.—A brush-holder which comprises a fixed support, an arm freely movable thereon, a socket for the brush on the arm, a relatively large screw-threaded lateral opening being formed in the socket, and a nut adapted to be screwed into said opening to secure the brush in good contact with the socket.

688,828 Speed-regulating device for overhead electric carriers; A. S. Clift, East Orange, N. J.—A carrier for overhead electric railways, of a brake and means for applying said brake with a force proportional to the steepness of the grade down which the car is running.

688,855 Earth-conductor for lightning-conductors; P. Immich, Charlottenburg, Germany.

688,861 Electric furnace; C. A. Keller, Paris, France.

688,869 Mechanism for raising contact-shoes on third-rail systems; S. H. Libby, Schenectady, N. Y.—A railway, a vehicle, means for transmitting power, a power collector carried by the vehicle and adapted to engage with said transmitting means, and means adapted to be engaged by the moving vehicle to cause the collector to be withdrawn and held from, and to resume and be held in, engagement with said transmitting means.

688,873 Electric mining machine; E. C. Margan, Chicago, Ill.

688,886 Encased electric time-alarm; A. P. Schloss, New York, N. Y.

688,891 Semaphore operating device; J. Shoecraft, Eskridge, Kan.

(Continued on page 38.)

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The Charleston Exposition.
REDUCED RATES VIA THE PENNSYLVANIA RAILROAD.
During the continuance of the South Carolina Inter-State and West-Indian Exposition, to be held at Charleston, S. C., from December 1 to June 1, the Pennsylvania Railroad Company will sell excursion tickets to Charleston and return from all points on its line at reduced rates. These tickets will be sold daily from November 30 to May 31, and will be of two descriptions: Season tickets, bearing a final limit of June 3, 1902, and eleven-day tickets, good to return within eleven days, including date of sale, but not good after June 3, 1902. These tickets will not be good to stop off *en route*. For rates and further particulars apply to Ticket Agents.

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PATENTS.

(*Continued from page 37.*)

688,915 Induction coil; D. H. Wilson, Chicago, Ill.

688,919 Electrostatic instrument; G. L. Addenbrooke, Westminster, England.

688,922 Electric railway; R. Bingham, West Haddonfield, N. J.

688,938 Igniter for gas engines; J. Eckhard, Brighton, N. Y.

688,964 Quadruple-relay crossing-signal; B. N. Parrish, Jackson, Mich.

688,970 Fire-protector for telephone cables; F. D. Saylor, St. Louis, Mo.—A tubular sheet of spring gauze, provided with an asbestos covering and lining, and adapted to be sprung open to encircle a telephone cable.

688,982 Automatic electric switch; A. H. Adams, London, England.

688,995 Electric heater; E. E. Gold, New York, N. Y.—Comprises an insulating open-work support, consisting of a grid of parallel bars separated to form ventilating spaces, said grid being formed of one piece of enameled sheet metal, slotted to form said spaces, longitudinally corrugated to form the bars, and transversely corrugated to form successive depressions in the bars, and a helix of resistant wire stretched across and supported by said bars, and lying in said depressions.

689,005 Apparatus for feeding sheets of paper to printing machines, etc.; Max Koenig, Guben, Germany.

689,096 Electrical apparatus; T. B. Kinraide, Boston, Mass.—Comprises a plurality of intermittent, high-potential, generating units, and means for uniting them in a unidirectional discharge.

689,128 Automatic electromagnetic time-switch; J. Sachs, Hartford, Ct.

689,130 Alternating-current meter; K. O. F. Schrottke, Berlin, Germany.

689,133 Electric clock; H. Seewald, Possneck, Germany.

(*Concluded on page 40.*)

SIGNALOID

THE MOST PERFECT AND RELIABLE . . .

Coloring and Frosting Liquid

. . FOR . .

INCANDESCENT ELECTRIC LAMPS

Will never peel, chip or crack, and the color will outlive the life of the lamp

MANUFACTURED BY

SIGNALOID CHEMICAL WORKS

Jersey City, N. J.

Pennsylvania Railroad Company will Issue Clerical Orders for 1902.

The Pennsylvania Railroad Company announces that clerical orders will be issued for the year 1902 to ordained clergymen having regular charge of churches located on or near the line of its road.

Application blanks may be obtained of ticket agents, and same should reach the General Office by December 21, so that orders may be mailed December 31 to clergymen entitled to receive them. Orders will be issued only on individual application of clergymen when made on blanks furnished by the Company and certified to by one of its agents.

OLD POINT COMFORT, RICHMOND AND WASHINGTON.

Six-Day Tour via Pennsylvania Railroad.

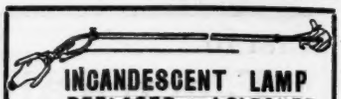
The first of the present series of personally-conducted tours to Old Point Comfort, Richmond, and Washington via the Pennsylvania Railroad will leave New York and Philadelphia on Saturday, December 28.

Tickets, including transportation, meals *en route* in both directions, transfers of passengers and baggage, hotel accommodations at Old Point Comfort, Richmond, and Washington, and carriage ride about Richmond—in fact, every necessary expense for a period of six days—will be sold at rate of $34.00 from New York, Brooklyn, and Newark; $32.50 from Trenton; $31.00 from Philadelphia, and proportionate rates from other stations.

OLD POINT COMFORT ONLY.

Tickets to Old Point Comfort only, including luncheon on going trip, one and three-fourths days' board at The Hygeia or Chamberlain, and good to return direct by regular trains within six days, will be sold in connection with this tour at rate of $15.00 from New York; $13.50 from Trenton; $12.50 from Philadelphia, and proportionate rates from other points.

For itineraries and full information apply to ticket agents; Tourist Agent, 1196 Broadway, New York; 4 Court Street, Brooklyn; 789 Broad Street, Newark, N. J; or Geo. W. Boyd, Assistant General Passenger Agent, Broad Street Station, Philadelphia.



INCANDESCENT LAMP REPLACER and CLEANER

HANDLES THEM AT ANY HEIGHT OR ANGLE

Incandescent Electric Light Manipulator Co.

116 Bedford St., Boston, Mass.

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REUTERDAHL ELECTRIC CO. PROV. R.I.

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ENGINE-STOP SYSTEM.

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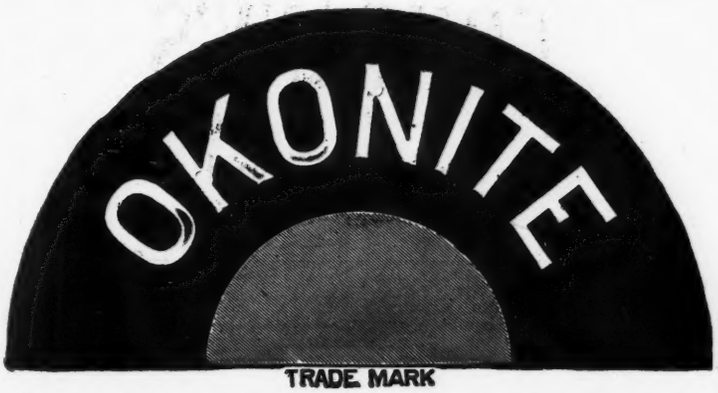

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THAT a STORAGE BATTERY is an Indispensable adjunct to Railway and Lighting Plants.

ALSO

THAT the "GOULD" embodies in its construction the highest development in the art of battery manufacture.

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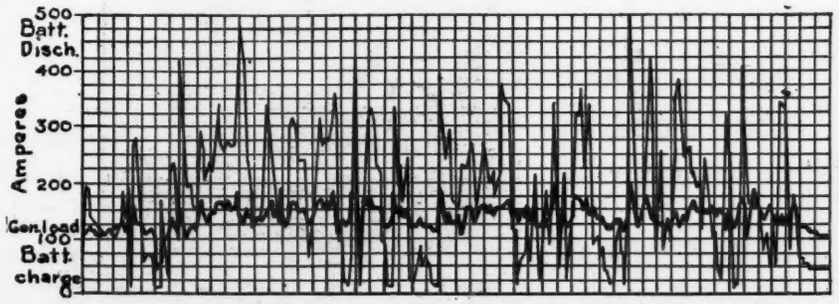

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reduces fluctuations on the Generators of a Railway Power-House.

Send for Bulletins describing Railway Installations.

THE ELECTRIC STORAGE BATTERY CO.

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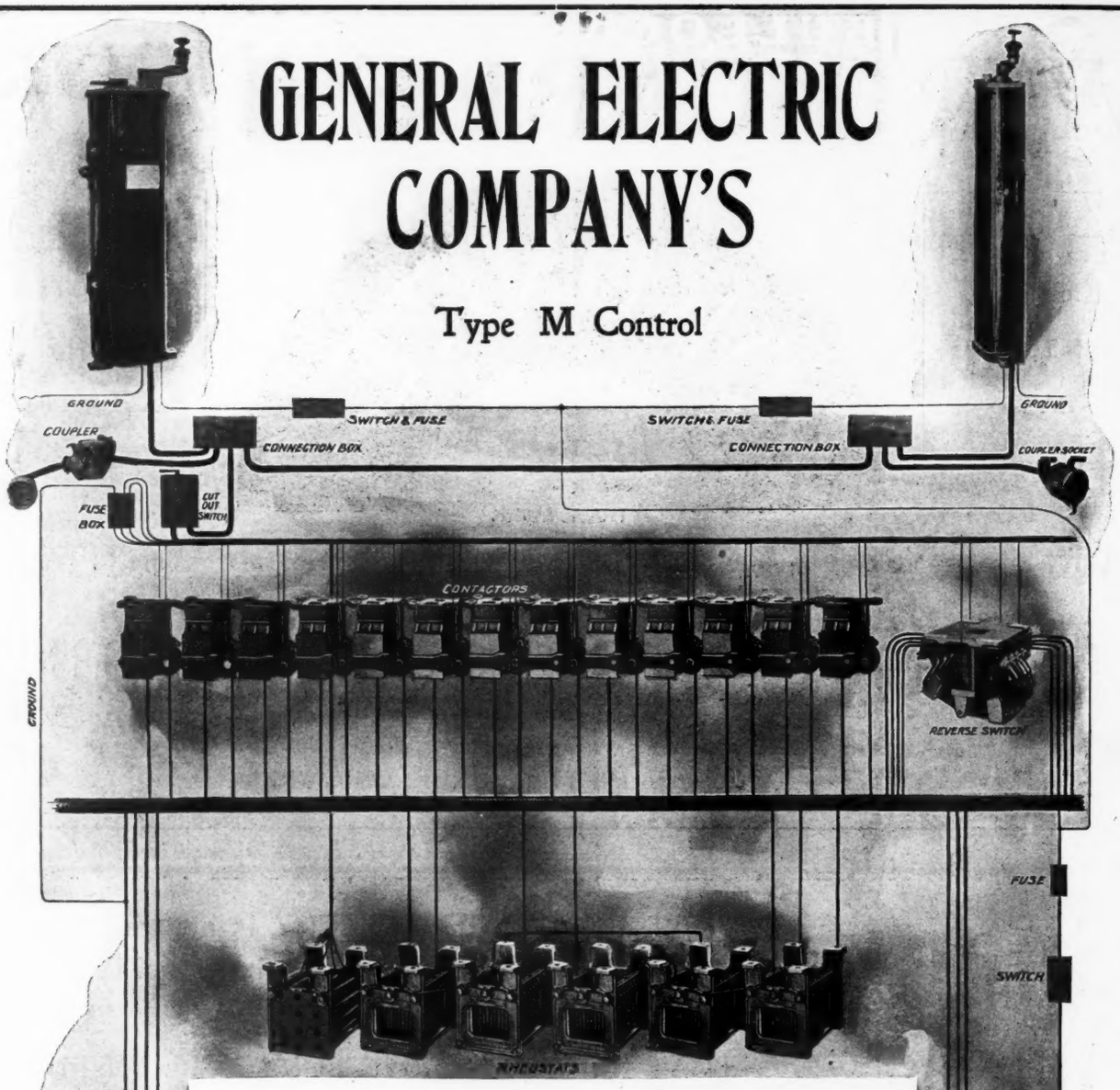
GENERAL ELECTRIC COMPANY'S

Type M Control



An effective, substantial and simple system for operating electric railway motors. Cars may be run either singly or in trains of any size from any one controller. The load is equally distributed among motors because all contactors (or motor controllers) act in positive synchronism simultaneously with the movement of the master controller handle.

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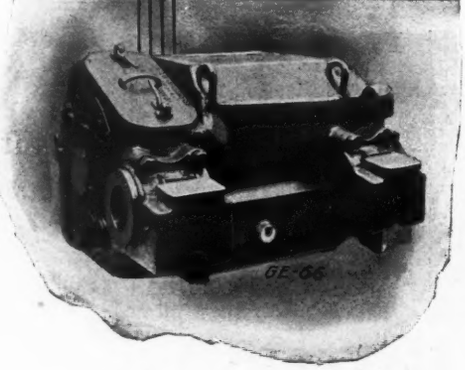

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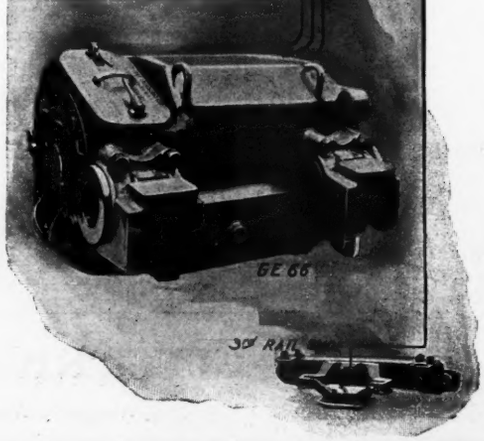

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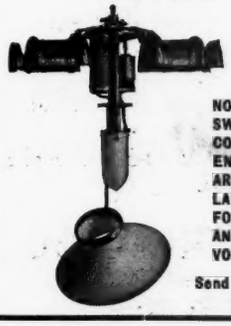

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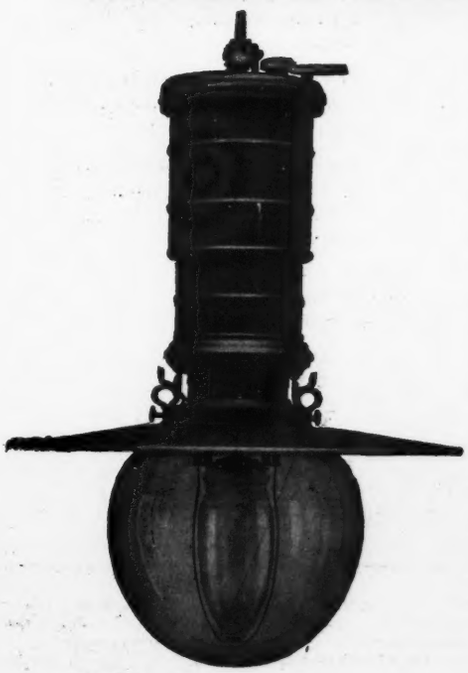

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Manufactured for Direct and Alternating Current
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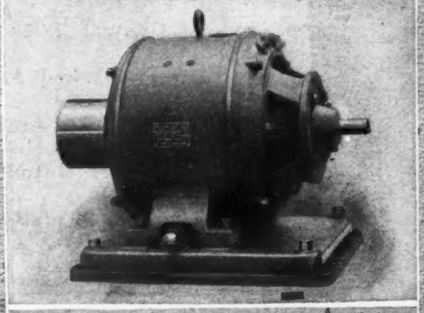
TYPE "N" MOTORS.
SUPERIOR QUALITY.



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We build both alternating and direct current dynamos and motors.

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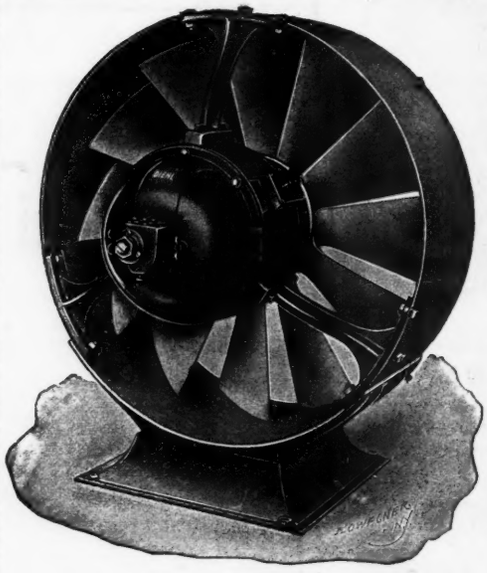

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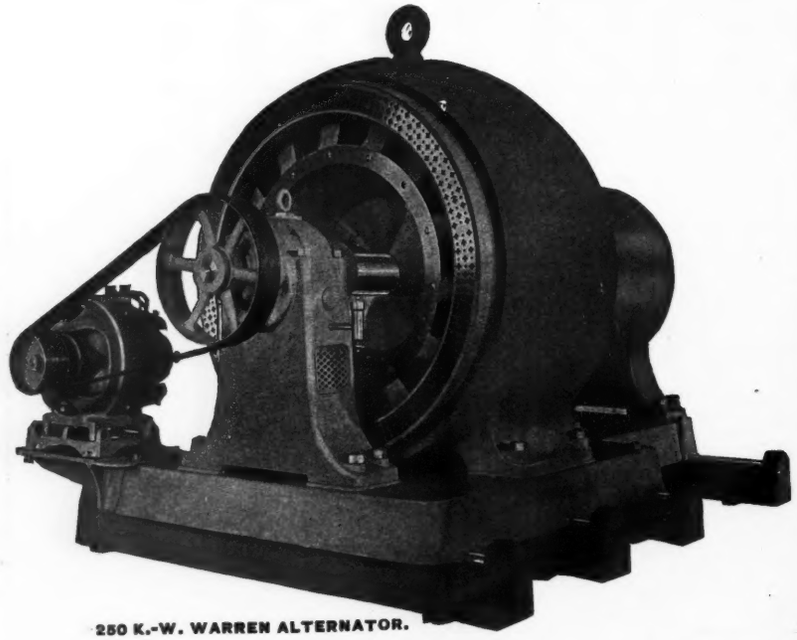

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You can move the Induced Coils, with the Inducing Coils stationary;

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You can move MAGNETIC LINES OF FORCE ONLY, leaving BOTH coils stationary, if you know how.

This is what is done in the best machine of its class,

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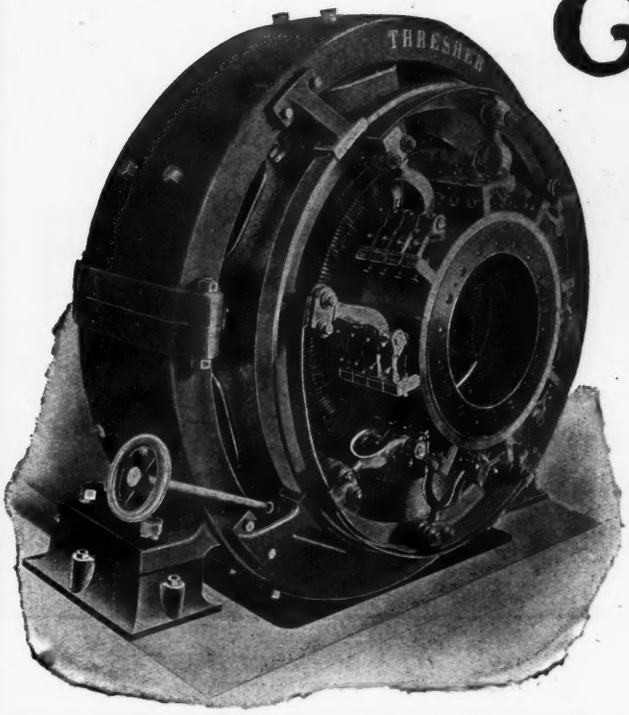

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Generators and Motors

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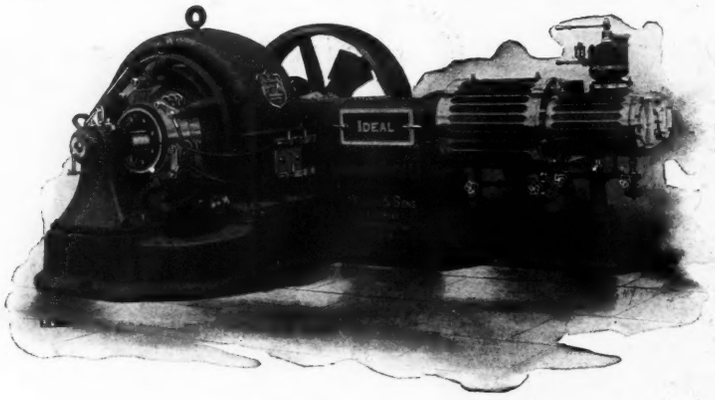

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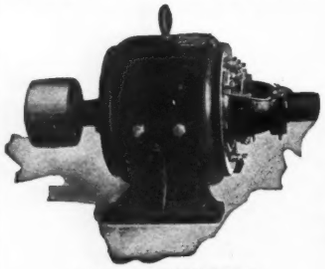

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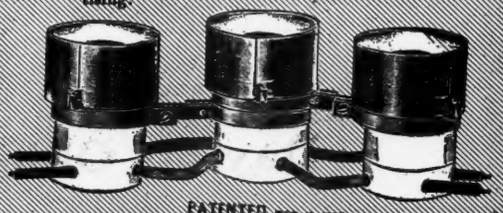

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Every Description of Electrical Material,
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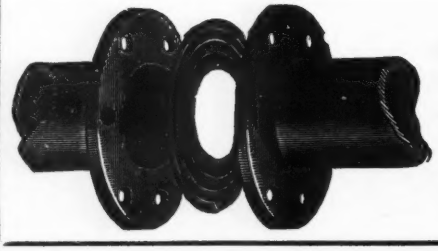
"NECO" Incandescent Lamps. Highest Grade Made.
WRITE US FOR PRICES.



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They save steam and make absolutely tight joints

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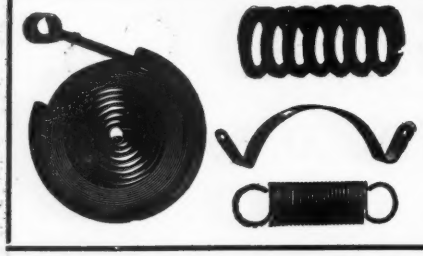

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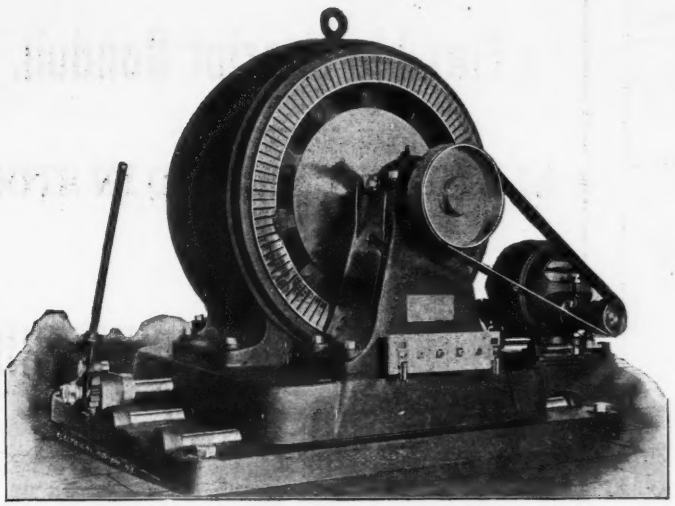

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Warren Alternator

No Moving Wire
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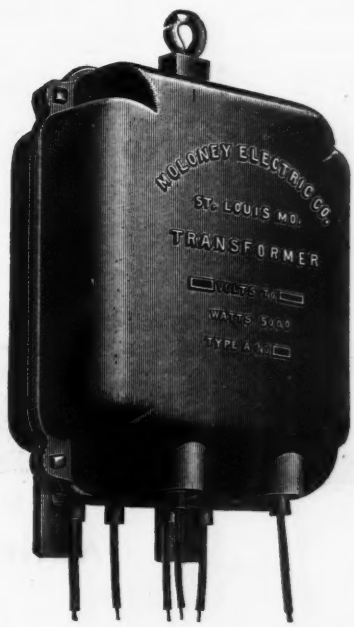

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Two Years' Guarantee

Let us send you bulletins, descriptive matter, prices, etc., on this apparatus.

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RUBBER COVERED **WIRES AND CABLES**

FOR EVERY SERVICE.

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For Underground, Aerial and Submarine use, "Safety" wires and cables have the indorsement of some of the largest users in the United States. Write for our booklet containing the experience of users.

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All sizes of stranded and flexible wire and cables with Clark's insulation.

Inspector Boston Fire Underwriters' Union says:—"A thoroughly reliable and durable wire in every respect."

The Clark wire has been before the public, and in use, for the past 10 years and has met with universal favor. We guarantee our insulation wherever used, Aerial, Underground, or Submarine, and our net prices are as low, if not lower than any other first-class insulated wire. We shall be pleased to mail Catalogues, with terms and discounts for quantities.

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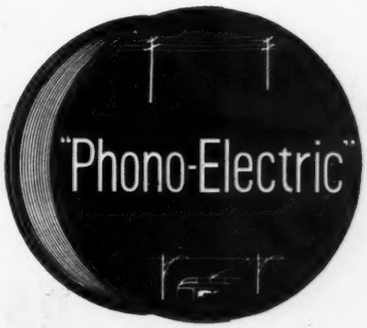

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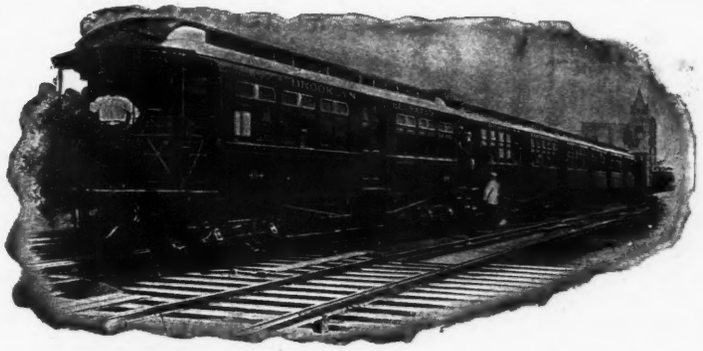

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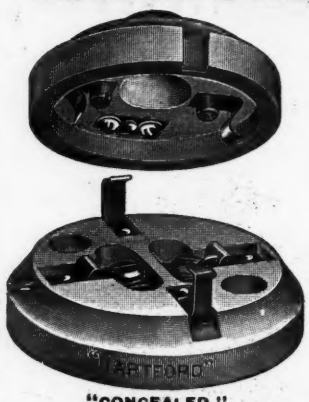

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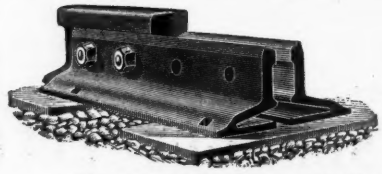

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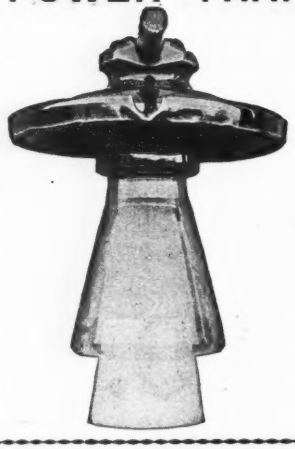

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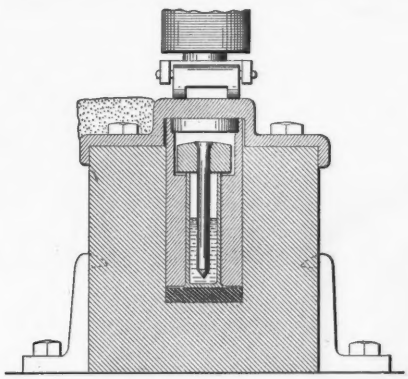

Fig. 1

Fig. 1 shows the working conductor and one of the circuit-closers, consisting of aluminum or copper stem and iron collar-head.

This system uses a sectional conductor (third-rail), under each section are placed the contact-making devices shown in Fig. 1. These consist of mercury cups mounted in insulating blocks and connected with the main feed. In each cup the circuit-closer is seated. All circuit-closing contacts are of carbon. The car carries two electro-magnets (shown in Fig. 2), attracting upward the circuit-closers. Thus the section of rail is energized, while as soon as the car passes the circuit-closers drop back, leaving the sectional rail "dead." The entire system laid in a space 8 x 10 inches.

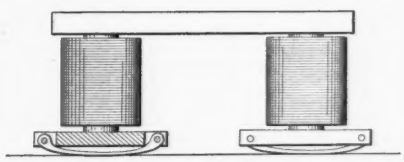

Fig. 2

Fig. 2 shows the electro-magnets attached to the car, hinged to which are the current-taking devices.

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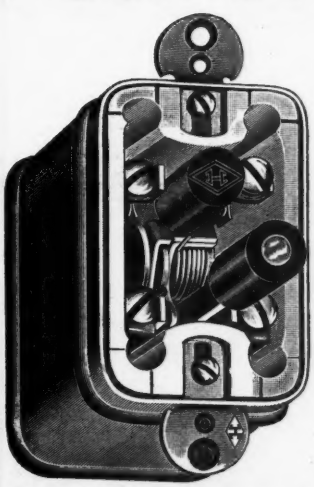

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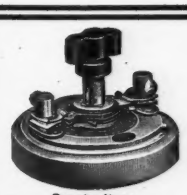

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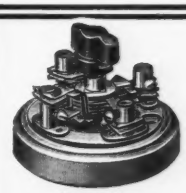

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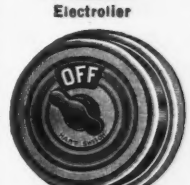

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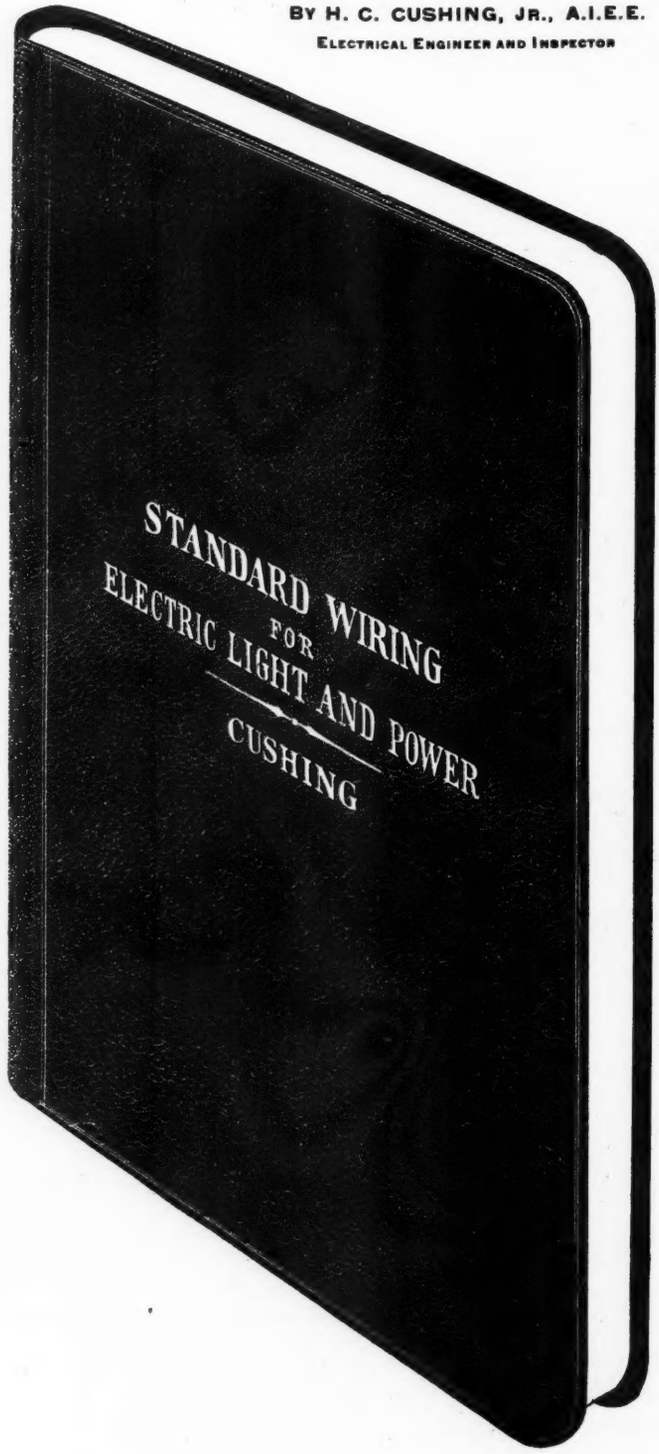

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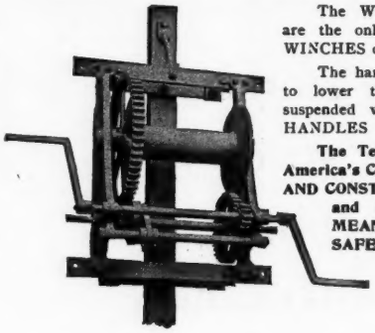

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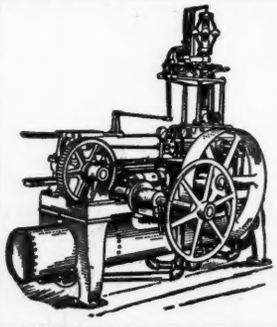

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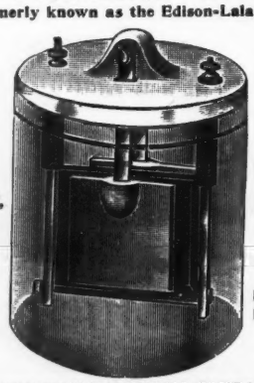

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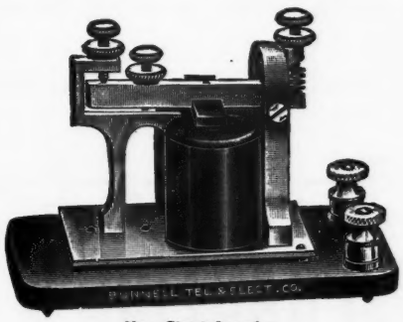

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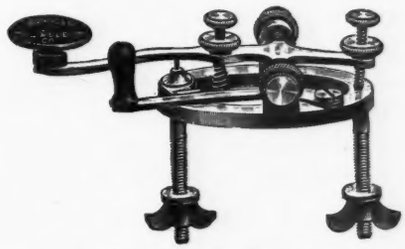

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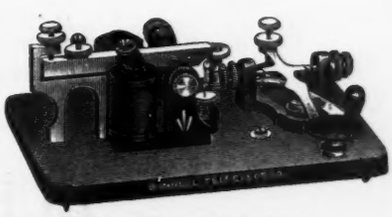

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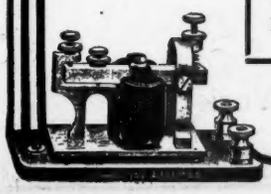

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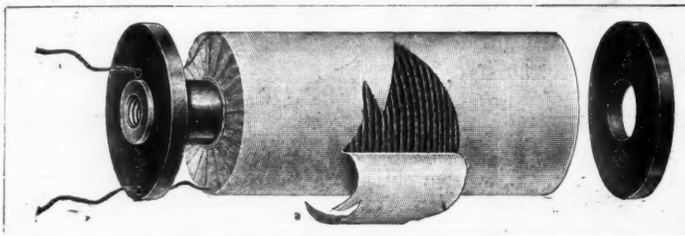

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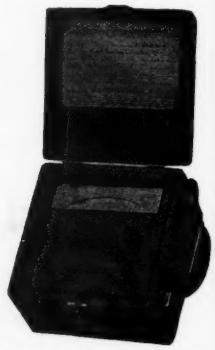

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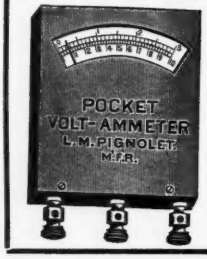

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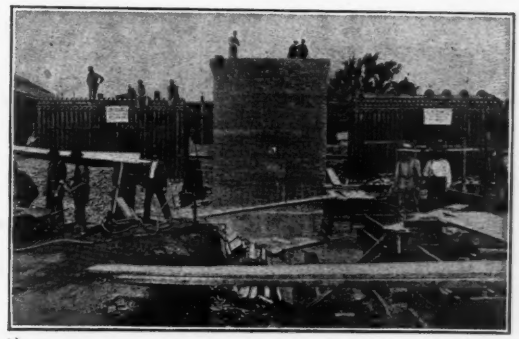

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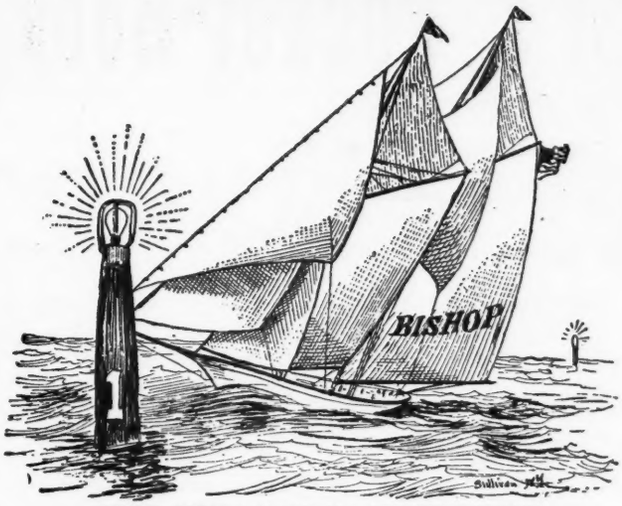

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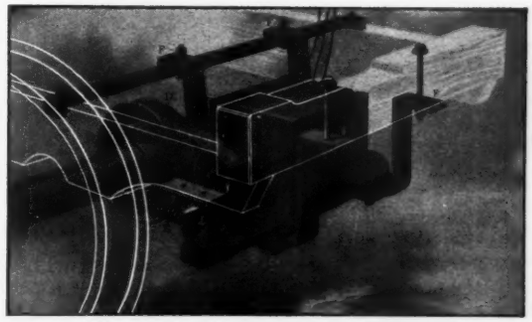

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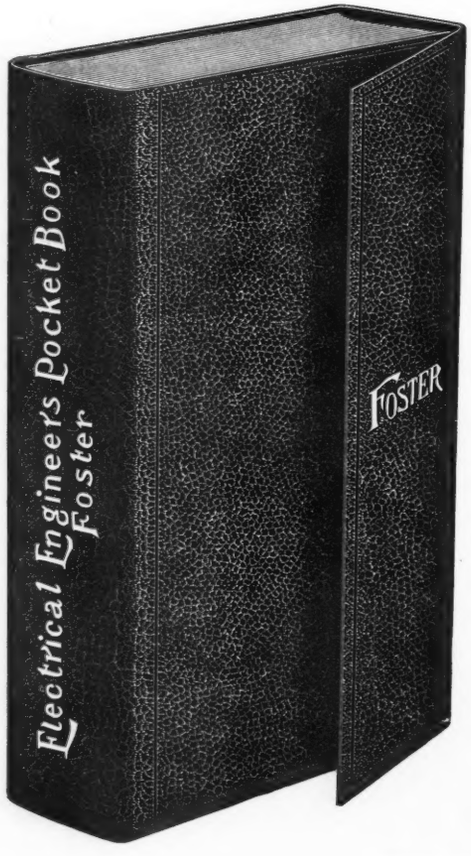

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It is with some little trepidation that this book is put before the public, in view of the frequent important and even radical changes that up to the present have characterized the development of electrical engineering. It has, however, been thought that the science has now reached a stage which renders necessary some manual that will be of assistance to the active worker in the various branches.

This book is not an encyclopedia, nor is it intended for a text-book, but it is hoped that as a compendium of useful data, it may assist the practising electrician and engineer.

The matter included is representative of American practice, and no effort has been made to include any other, except in special cases.

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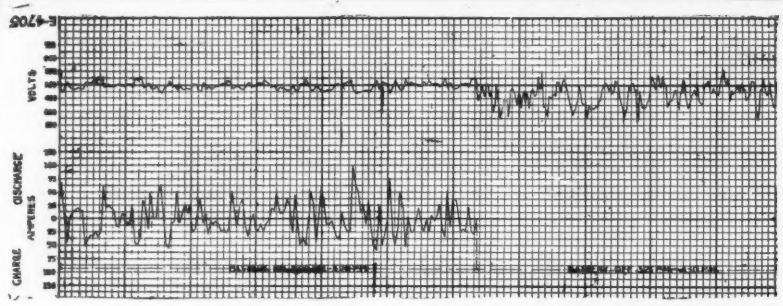

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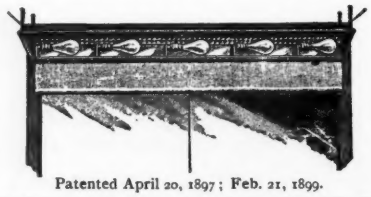

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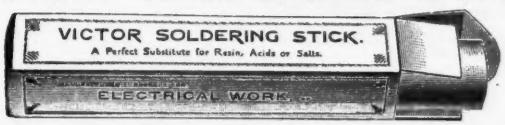

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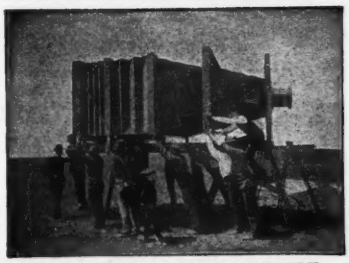
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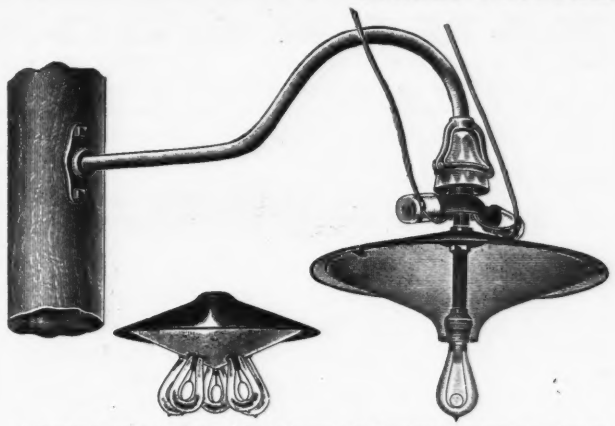
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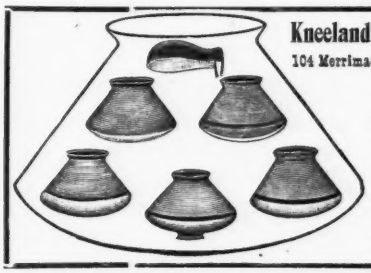
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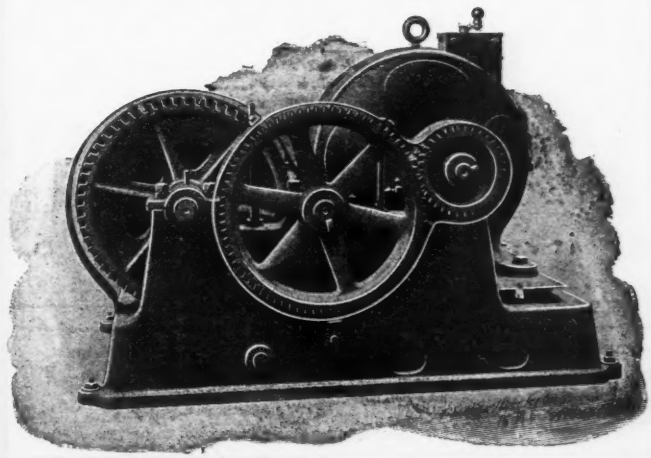
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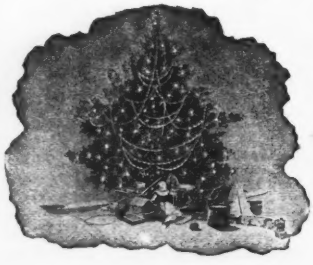

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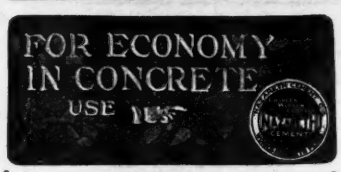

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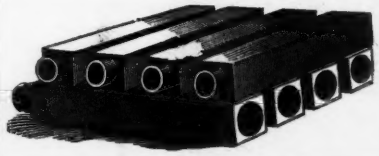

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